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ANNALS of SURGERY

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EPITHELIAL HYPERPLASIA OF THE BREAST

BY SIR GEORGE LENTHAL CHEATLE, F.R.C.S.

OF LONDON, ENG.

THE glandular elements of the breast are developed from the surface epithelium. The site of the future breast is marked by a mere dimple from which branches of epithelium penetrate the underlying mesoblast. It is accurate to regard the breast as a gland derived from the skin, hence it is very interesting to compare the reactions of the skin and the epithelium of the breast to local irritation. Let me take first the reaction of the human skin to the application of tar. The reaction is marked by a sequence of events which respectively appear after definite lapses of time so that young tar workers suffer from different lesions to those that affect the middle-aged and the lesion that affects still older workers is different from those that affect the young and middle aged.

Among the first things to be noticed is a desquamative epithelial hyperplasia combined with which there is frequently a hyperplasia of the underlying connective tissue which consists of newly formed fibrous tissue and possibly a collection of small round cells with large nuclei exactly resembling lymphocytes. Young tar workers suffer from this lesion.

As time advances, the second event that attracts attention is the formation of papillomata or warts, the epithelium covering which is not desquamative in type. For want of a better nomenclature I apply the term "dysgenetic" to distinguish it from the purely desquamative type. By "dysgenetic epithelial hyperplasia," I mean pathological epithelial growth.

Third in the sequence of events is a dysgenetic epithelial hyperplasia that morphologically looks like squamous epithelium, although it is completely limited within normal boundaries. Spontaneous cure often happens by a sloughing out of the lesion. The period of life at which this lesion occurs is early middle age.

The fourth and last event in the sequence is the appearance of a typical squamous epithelium the cells of which invade and undergo metastasis. The lesion affects the workers of about forty-five years of age and onwards. The application of X-rays to the human skin induces the same pathological changes and in the same sequence and corresponding times.

Before leaving this part of my subject, I must say that precisely the same

morphological changes occurring in the same sequence in corresponding times also occur in the skin of mice after the application of tar. The whole sequence takes up about a quarter of a mouse's lifetime. The importance of calling attention to these experiments in mice is that it enables one to allude to an observation made by Dr. A. J. Murray, F.R.S. From the growth in a mouse, suffering from the third event of my sequence, Doctor Murray transplanted epithelial cells into the underlying tissues of the same animal where they grew and from where they metastasized. They behaved like malignant cells after they were removed from a growth that was strictly limited to normal boundaries. Were these transplanted cells malignant when *in situ* or did they become malignant only when they were transplanted? Doctor Murray's experiment is interesting because its significance can be applied to the third event of my sequence which I described in human tar workers. Before concluding my observations on the effects of tar on the human skin, I wish to call attention to the fact that in any one of the first three changes, intercurrent impulses may arise that may arrest or prolong them or hasten them into the fourth and final catastrophe of carcinoma.

Now let me compare the pathological changes in the epithelium of the breast with those I have described in the skin. It will be seen that they are identical in type and sequence. The first event in the sequence of pathological epithelial changes in the breast is a desquamative epithelial hyperplasia that occurs mainly in terminal ducts alone or acini alone or in terminal ducts and the acini communicating with them. I wish the reader to note particularly the site of this change, *viz.:* the terminal ducts and acini because it is here that a common type of carcinoma begins.

There are two types of desquamative hyperplasia: The first is a very diffused and generalized form which results in a collection of degenerated, dessicated, small atrophied epithelial cells. The state is capable of inducing great pain. Besides occurring diffusely throughout a breast, it is also seen in fibroadenomata. The second type is a much more important type because the subsequent events of the sequence are seen occurring in its presence, as if it were a factor in inducing their presence. The important facts to note about it are that it exists alone, it is less generalized than the first type of desquamative epithelial hyperplasia, I have just described. It has special histological features and it is as a rule painless. Like the first type, it begins in the terminal ducts and acini, either of which may contain, separately, the lesion. The cells of ducts and acini become elongated and feathery. The whole or only part of the lumen may be affected; only in the ducts the process ends in a collection of colostrum-like cells which can be seen in all stages of formation arising from the feathery cells of the ducts. There is also a hyperplasia of the peri-canalicular and interacinous connective tissue where newly formed fibrous tissue is seen and among which there is an occasional collection of lymphocytes. Unlike the skin the ducts and acini possess

apposing walls which are distended by the accumulation of cells resulting from the process of desquamation. Hence the process is one of the causes of cysts in the breast. Desquamative epithelial hyperplasia affects the breasts of women of about thirty years of age.

The second event of sequence is the formation of papillomata, which may grow in an ampulla only, but usually they are much more general in distribution when they affect the whole duct or more than one duct, a fact that is beautifully demonstrated when whole, microscopic sections of a breast are cut in series.

The third form of epithelial hyperplasia and next in sequence is a dysgenetic hyperplasia that morphologically looks malignant and yet shows no sign whatever of having transgressed natural boundaries. Like desquamative epithelial hyperplasia, it affects mainly acini and terminal ducts. This third stage corresponds to the third stage of pathological changes I have described in human skin after the application of tar. I regard it as malignant and would refer the reader to the significant experiment performed by Dr. A. J. Murray, which seems to me to be as applicable to this state of the breast as to tar carcinoma. The age of the patient is usually about forty years.

The fourth and last event in the sequence is carcinoma. Epithelial cells have invaded outside structures and metastasized. The invading cells have been derived from a dysgenetic epithelial hyperplasia occurring in the terminal ducts and acini. The site of this dysgenetic growth is the same as the pathological changes in the first and third events of the sequence. The age of the patient suffering from this event is usually forty-five years. In the lesions of the first three events in the sequence of breast changes there is microscopic evidence to show that the epithelial cells may degenerate and die and that the process may be arrested. Hence the pathological changes in the epithelial elements of the breast are identical in sequence and respective characters to those that occur in the skin after the application of tar.

To make myself clear in the final remarks of my paper, it is essential to repeat, in the order of their sequence, the pathological changes I have described in the skin and in the breast. They are as follows:

1. Desquamative epithelial hyperplasia.
2. Papillomata.
3. Hyperplasia of epithelial cells that morphologically look malignant and yet are strictly confined within normal boundaries.
4. Carcinoma.

The epithelial hyperplasia in 2, 3, and 4 are dysgenetic and not desquamative in type.

A. It may be wondered by what right do I attribute the pathological changes I have described in the breast to direct local irritation. A great deal of my work has been devoted to the study of epithelial changes in the ducts and acini. I have made it a necessary feature that the microscopical

examination should be made from complete microscopical sections of the whole breast. To enable one to do this, I have had made a large microtome, so that I can examine sections of whole breast that have been cut in paraffin and in series. Sometimes a whole duct as it enters and empties itself on the surface of the nipple can be examined, it is patent from beginning to end, and there appears nothing to prevent the entrance of agents of irritation. Also, a study of these whole sections demonstrates the fact that only one duct and its branches may be affected throughout its whole length by papillomata. The affection of only one duct compels one to assume a local irritant applied to that particular duct and not to any other ducts. The third and fourth states in my list may also exist only in one duct and its branches in respective breasts. Lastly, there is the evidence of the same types of lesions in the skin which are known to be induced by the direct effect of local irritation.

B. Under the titles of desquamative and dysgenetic epithelial hyperplasia, I have described pathological lesions that are regarded as being those of "chronic mastitis." I think the term is erroneous and misleading. I consider too many and important lesions are grouped under this term. More important still is the fact that they are all forms of hyperplasia. Incomplete as knowledge is upon all forms of growth, yet more is known concerning them than when the term "chronic mastitis" first crept into the nomenclature of disease. It is time that all forms of growth were now spoken of in terms of "hyperplasia" and not in terms of "inflammation." The use of the term "hyperplasia" at once creates a true conception of the changes that are being induced and leads to correct trains of thought that concern the possible and probable futures of the lesions that are under particular review.

C. The fact that desquamative epithelial hyperplasia is among the first lesions to be produced by direct local irritation makes its relation to carcinoma possible and indeed probable. There is another fact that increases the probability. It occurs in the same parts of the breast as carcinoma, *viz.*: in the terminal ducts and acini. I regard desquamative epithelial hyperplasia, particularly the second type of it, as a definite preliminary state to carcinoma, but one in which carcinoma is not an inevitable result. Many factors and impulses may arise that arrest or prolong the progress of the condition or even hasten it into carcinoma. In discussing precancerous states, I believe the most important one and that which is nearest to the final catastrophe of carcinoma is the third event in my list. That from which Dr. A. J. Murray when experimenting on a mouse transplanted some epithelial cells from the position in which they were growing into the underlying tissues of the same animal. In their new situation these cells grew and metastasis occurred. The questions of importance here are, were these cells malignant in the position where they were growing, or did they become malignant only when they had been transplanted? In considering this point it must be borne in mind that when the papillomata (the second event in sequence) are thus

transplanted, the transplanted epithelial cells either atrophy or develop an implantation cyst, they do not metastasize. Hence the third state of my sequence of events is the nearest state to carcinoma without being carcinoma, and therefore it is the real precancerous state. Examples of the third event can be seen in all instances of carcinoma of the breast, where the epithelial invasion has not given rise to chaos that obliterates all normal structures. Even when carcinoma exists in a breast, it is extremely difficult to detect the actual focus or foci where the epithelial cells escaped from their normal boundaries. Although I consider the third event of the sequence the truly precancerous state, yet I consider that there is no state of epithelial hyperplasia that will inevitably terminate in carcinoma. So long as dysgenetic types of epithelial hyperplasia are strictly confined within normal boundaries, some intermittent impulse may arise that induces their atrophy and disappearance or prolongs their confined existence.

D. The recent work of Doctor Gye and Mr. Barnard is of such vast importance that it will necessitate a fresh orientation of all notions that prevailed before their work was published. For this reason I have tried to confine my statements to those events that may be explained but not materially altered by their work.

ACUTE HYPOTENSION OF CEREBRO-SPINAL FLUID FOLLOWING CRANIAL TRAUMATISM

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and
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It is a matter of fact that the pressure of the cerebro-spinal fluid is lowered in some cases of cranial trauma. In these cases the evacuation of cerebro-spinal fluid by lumbar puncture leads to an exaggeration of the nervous accidents while on the contrary the raising of its pressure has at once a favorable influence and transforms the condition of the patient. Hypotension of the cerebro-spinal fluid therefore seems, to some extent at least, to play a prominent part in the symptomatology of cranial traumatism, and the actual existence of a well-individualized syndrome of acute hypotension of the cerebro-spinal fluid seems to be established beyond doubt.

M. Leriche has been the first to point out these hitherto unknown facts. He proposed at first the treatment of this hypotension by hypodermic injection of artificial serum; later on, suggested by the research work of Weed and MacKibben, he tried intravenous injection of distilled water by which he obtained a very quick modification of the hypotension of cerebro-spinal fluid. He further tried to verify in man the data given by the experimental work of the American physiologists. The application of the new therapeutical method to man in a case of severe fracture of the pars petrosa with discharge of cerebro-spinal fluid by the ear, demonstrated with experimental accuracy the influence of distilled water injection on lowered pressure. The intravenous injection of 30 c.cm. of distilled water raised in some minutes the volume and the strength of the discharge while at the same time the patient came out of the comatose state in which he was plunged. Every new injection produced the same phenomena.

In this clinical case the hypotension was caused by a loss of cerebro-spinal fluid that could be both seen and evaluated.

In cases of skull fracture without apparent discharge of cerebro-spinal fluid hypotension is also met with rather often. Theoretically, every time the subarachnoid spaces are opened, the equilibrium of the fluid is broken and the pressure may decrease more or less quickly. We have observed the syndrome of acute hypotension even in cases of less severe cranio-cerebral traumatism, in which the signs of important lesions of the cranium were wanting and we had merely diagnosed commotio cerebri.

The three cases whose record we think interesting to give are patients of

M. Leriche. They all showed hypotension of cerebro-spinal fluid without having presented unmistakable signs of skull fracture.

Case I.—The first patient, L., eighteen years old, was hit by a big piece of wood on the head on January 13, 1925. He lost consciousness. Was brought to the ward at 9 A.M. He regained consciousness soon after but was in a very marked state of shock, being cold, pallid, with a pulse at 60, and answered questions in a tired and prostrated way. The reflexes were normal but exaggerated; the pupils were equal, round, their reflexes well marked. There were no signs of paralysis or contracture. There was hæmatoma of the left parietal region. The pulse was stronger after some hours, but the patient remained pallid and prostrated; lumbar puncture practised at noon showed a sanguinolent fluid that issued in a "jet."

The needle of Claude's apparatus rises to 75 (lateral decubitus), but falls quickly to about 0 and stays there. After intravenous injection of 35 c.cm. of distilled water, the patient feels better, opens the eyes and answers our questions more readily. The needle of the manometer has risen to 12.

In the evening pulsations are more frequent and stronger. The next morning the patient feels very well subjectively, his face is well colored, the pulse beats at ninety, the cephalea has disappeared. In the evening, the subjective state becomes again less favorable, the cephalea has reappeared. A new lumbar puncture produces only a few drops of sanguinolent fluid, the manometer indicating no pressure whatever. A second injection of 25 c.cm. of distilled water raises the pressure slowly to 8, 10, 11 and 12. After this injection the patient feels strikingly improved. His condition remains the same till January 23. On this day a lumbar puncture shows a pressure of 45/47. No incident is noted after this last puncture, the patient leaves on the 29th, perfectly well.

Case II.—The second patient, Leo O., twenty years old, falls downstairs, striking on his occipital region, on November 19, 1924. He was brought to the ward in a state of pronounced stupor, but he was still able to answer questions satisfactorily. He had no recollection whatever of his accident and did not remember how he got to the ward. He complains of excruciating occipital cephalalgia; has not vomited. Pulse beats at 84, temperature 37.4° C. The pupils are extremely dilated, of equal width, react to light. The tendinous reflexes are normal; there is no Babinski, no paralysis, no contracture. On the other hand, there are no local signs of fracture of the base. Lumbar puncture, practised on the patient's arrival, gives issue to a clear fluid, showing a pressure of 40 cm. of water, the patient being sitting up at the time.

On the next morning the patient is still markedly stuporous; he keeps quiet with his eyes open and answers lazily the questions he is asked. The day afterwards he is about in the same state. His pulse is full but somewhat slow; he feels vertigo when made to sit up in bed. The pupils remain enlarged. On the third day, more than forty-eight hours after the traumatism, the patient begins to vomit, his torpidness increases and becomes nearly semi-coma. Pulse remains full but is markedly slower, beating at 64 instead of 70 and more the days before. His paleness is striking; the pupils react well, the reflexes are normal, the breathing is superficial; not accelerated. Lumbar puncture at 10 A.M., there issues a simple drop of transparent fluid. The manometer indicates no pressure. A second puncture is then practised one intervertebral space higher, without any fluid issuing.

We inject 30 c.cm. of distilled water into a vein of the patient's arm. The arterial pressure, measured with Pachon's oscillometer, stood before the injection at 15/9, index 2, and fell after the injection to 13/8, index 1.5. Immediately after the injection the patient awakes from his torpidness, sits up in bed, gives quick and precise answers and

knows easily his surroundings. The pupils, widened before, are now contracted. In the afternoon the pulse beats up to 72. In the evening (6 P.M.) the patient is vomiting again, complains of cephalalgia, is again stupid, and remains stretched helplessly in bed, assuming an attitude "en chien de fusil." The pulse lowered down to 62. The patient gets a hypodermic injection of physiologic serum without perceivable result. In the night vomiting reappears.

On the fourth day the pulse stays at 60, the torpid state is unchanged, the patient is still lying "en chien de fusil." At first sight one thinks of a meningeal state, though there is no Kernig, no well-defined stiffness of the neck. About 10 A.M., 30 c.cm. of distilled water are again injected after a new lumbar puncture has given issue to no fluid whatever nor evidenced any oscillation of Claude's manometer. The injection of water does not produce the same instantaneous improvement as on the day before, but the patient ceases to groan and his pupils contract themselves. The arterial pressure taken before the injection stood at 15/9, index 2.5, and drops after it to 14/8, index 2.

Six hours after the injection manifest improvement is perceivable, the patient answers gaily the question he is asked, he takes food with relish. The pulse has risen to 68. Nine hours after the injection he is found out of bed, is feeling gay and cannot understand why he should be ordered back to bed. The pulse beats at 76. From this time on the improvement is definitive. Lumbar puncture, practised three days later, shows a pressure of 45–50 cm. water; after abstracting two c.cm. of clear fluid, the pressure falls to 35–39. Two days later, the patient leaves the ward, quite well again. He has been seen seventeen days after leaving the hospital and enjoyed excellent health.

CASE III.—The third patient, G. H., sixty years old, falls downstairs on January 13, 1925, and is found laying insensible two hours afterwards. On arriving at the clinic, the patient answers with difficulty and slowly the questions he is asked. He is somnolent, presents some superficial and trivial wounds of the nose and the occipital region. He feels no pain. Pulse, 76. Reflexes, normal. Diagnosis made, slight commotio cerebri.

On the next day the patient remains stuporous. His state being stationary in the evening, lumbar puncture is practised. The pressure as shown by Claude's apparatus is 5 cm. water in lateral decubitus, falls soon to 2 cm. The puncture needle being left in the spinal canal, 30 c.cm. of distilled water are injected intravenously; during the injection, the indicator of the manometer shows some oscillations, the pressure rises to 10 and reaches 12 cm. It must, however, be noted that it does not keep up and quickly drops to 0. Five minutes later it has not risen again.

On the 15th and 16th of January the condition of the patient remains stationary. A new injection of 20 c.cm. of distilled water, practised on the 16th, makes the pressure rise from 15 to 20 cm.

On the next day (January 17) the patient feels better, is no more mentally confused, takes even food with some appetite, but on the 18th grows somnolent again. A third injection of 35 c.cm. of water is practised. The state of the patient is strikingly changed in the evening; he has come out of his torpor and takes a sensible interest in his surroundings. On the next day the patient shows quite normal. He is kept under observation for eight days more, till January 28, when he leaves the hospital, quite well again.

The analysis of these three cases shows that the three patients exhibited the same symptoms, *viz.*, an evident hypotension of the cerebro-spinal fluid, manifest in the first and third case on the very first puncture, in the second case it was definitely found on the third day only, the lumbar puncture on arrival at the clinic having shown a pressure of 40 cm. It is evidently difficult

to say in this case whether the hypotension observed on the third day after the aggravation of the general symptoms belongs to a post-commotional syndrome of a special type or whether there was a loss of cerebro-spinal fluid through a gap of the dura mater such as could have been produced by the badly constructed puncture needle that had been used for the first exploration.

From the therapeutic point of view, our action has been nothing but a fight against the hypotension of the fluid. The nervous symptoms exhibited by the three patients have been rapidly improved and completely cured by intravenous injections of distilled water. The first and second have been transformed by the first injection and remained in a state of equilibrium, the first for about thirty, the second for ten hours; both relapsed into a state of marked sleepiness and mental confusion after this time; the first patient suffering again from cephalalgia and vertigo, the other from vertigo and vomiting with slowing of the pulse. In both lumbar puncture evidenced a renewed fall of the pressure of the cerebro-spinal fluid. The second injection of distilled water cured both definitively, and in one of them, when the puncture needle had been left in the medullary canal while still connected with the manometer, the pressure rose under our eyes from 0 to 12 cm. Finally lumbar puncture was again practised on both some days afterwards, before they left the hospital and showed a quite normal pressure of the cerebro-spinal fluid. The third patient who showed initial pressure of 5 cm. that soon dropped to 2, rose to 12 after the injection of a very slight quantity of distilled water, but dropped afterwards back to 0, received no benefit from the first injection of water. For forty-eight hours he remains stuporous and stays without treatment. He then gets in the evening a second injection of distilled water and is better on the next morning, but grows somnolent again the day after, and a third injection of water shows no effect. It is only the fourth and more voluminous injection that definitely gets him out of his torpor.

The facts can therefore not be denied. The rational treatment of acute hypotension of the cerebro-spinal fluid is the intravenous injection of from 30 to 40 c.cm. of distilled water. The method is at once easy and safe. It may be advisable in order to secure a definitive result to repeat the injection twice or more. It seems indeed that sometimes the pressure becomes only stabilized after two or three hypertensive injections.

The acute hypotension of the cerebro-spinal fluid has rather well-defined clinical features described by M. Leriche. Sometimes there is lasting frontal cephalalgia (such as is seen in certain trephined patients with depressed cicatrix, and after lumbar anæsthesia). The headache can be accompanied with nausea, vomiting and giddiness (second case). There is noted sometimes semi-coma, but more frequently torpor and mental stupor. All these symptoms make one think of an attenuated meningeal state, or even of meningitis, when they are associated as it has already been remarked with

other signs like slight stiffness of the neck, position "en chien de fusil" and Kernig's sign.*

The differential diagnostic of hypotension and hypertension will not therefore meet with insuperable difficulties. In some cases the exact diagnosis may be foreseen clinically even before Claude's apparatus has been applied. The manifestations of hypertension are as a rule more apparent and striking. There is often motor agitation, the pulse is notably slower, hard and tense, the breathing accelerated, symptoms indicating the more or less pronounced irritation of the pneumogastric nerve centre. When there is a more considerable compression, when the bulbar centres begin to get paralyzed, the pulse becomes faint, rapid, irregular, there is slow breathing with stertor. The clinical aspect of hypotension is different in every point from that of great hypertension. To mistake one for the other is impossible. It is only the attenuated traumatic hypertension, with badly defined and incomplete signs, that could lead to a mistake, and this mistake would be easily corrected by an explorative lumbar puncture, which always should be completed by the measuring of the pressure of the fluid.

The clinical criteria we have given appear somewhat uncertain compared with the accurate data that this determination yields and with the criterium "ex juvantibus" constituted by the effect of the therapeutical hypertensive injection.

In this paper we have let the facts speak for themselves without interpreting them and do not construct any theory. We only wish to lay stress on the frequency with which the syndrome of hypertension of the cerebro-spinal fluid occurs in cranial traumatism and the efficiency of the therapy we nowadays apply to it.

Why is this therapy hypertensive for the cerebro-spinal fluid? The question appears intimately involved with the problem of the elaboration of the cerebro-spinal fluid and the upkeeping of its equilibrium. In our experimental work on animals, we have obtained the confirmation of the results gained by Weed and MacKibben. We have been able to raise the pressure of the fluid by injecting distilled water into the blood, but the intimate mechanism of these phenomena that appear so simple in their reality and so easy of observation, remains hidden from us. All we can suppose is that the injection, notwithstanding the apparent want of other reactions, produces a

* The clinical signs of hypotension following spinal anæsthesia can be sometimes very pronounced and bear peculiar features. Severe cephalea, somnolence, marked stiffness of the neck, very evident Kernig's sign could lead one to believe in infection of the meninges by subdural injection of the anæsthetic. These fears are absolutely unfounded, since these signs are brought about by the hypotension of the cerebro-spinal fluid and vanish within a quarter of an hour after the intravenous injection of distilled water. In two cases, that came recently under our observation, we have witnessed the rapid disappearance of all meningeal symptoms. In both cases a single injection had an immediate and lasting curative effect.

modification of the osmotic exchanges between the blood and the cerebro-spinal fluid and that this takes place in the subarachnoidal spaces and in the dialyzing organ, represented to all appearance by the choroid plexus.

Further experimental research of the histo-physiological modifications of this organ might throw some light on this interesting question.

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END RESULTS IN NEURO-SURGERY*

IMPRESSIONS DURING DECADE 1913–1923

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During the past two years, I have been reviewing the records and examining the patients operated upon during the decade of 1913 to January the first, 1923. The records of only 73 per cent. of these cases could be completed up to date—the greatest difficulty having been encountered in locating the traumatic ward patients and the ambulance cases. My impression of the end-results from the standpoint of the ability of the patient to earn a living and to be a useful member of the community has been discouraging and particularly is this true of those patients having had lesions of the central nervous system, such as brain tumor, brain abscess, chronic brain injuries, and internal hydrocephalus, whereas more encouraging results have been obtained in the operative treatment of trifacial neuralgia, lesions of the spinal cord, brachial plexus and of the peripheral nerves, external hydrocephalus in its milder forms, chronic brain injuries of supracortical hemorrhage, and then, possibly the most gratifying of all, the treatment of acute brain injuries, both in the newborn and in adults. It is the hope, however, that a much more favorable report can be made at the end of the next decade. In searching the literature for detailed reports regarding the end-results in neuro-surgery, it has indeed been very surprising not to find such reports upon any large series of cases—merely reports of individual cases in detail and for a period of only two or three years after operation, and then the grouping together of brain conditions under one heading and considering the operative mortality rather than the end-result from the standpoint of a normal individual; the cerebello-pontine angle tumors of the auditory nerve, and usually benign in character, and the operative relief of trifacial neuralgia, with an operative mortality of less than two per cent., and a permanent relief of pain, can in no way be compared with the seriousness of cerebral gliomata, subcortical abscess formations and the various types of hydrocephalus and chronic brain injuries from the standpoint of future normality—physically, mentally and emotionally.

Within the past twenty years, a tremendous advance has been made in the field of neuro-surgery. There have been three main factors in this development:

First.—The pioneer work of men like Horsley, Von Eiselberg, Krause, Chipault, and Chaput, and in this country Keen and Hartley, and then more recently and preëminently, Cushing. At present there is a group of younger men throughout the country all making valuable contributions to this subject.

* Read before the New York Neurological Society, June 2, 1925.

The second factor has been a better team-work between the neurologist and the surgeon—the neurologist, by improved methods of examination, is making possible earlier diagnosis and more accurate localization of the lesion, and the surgeon, by understanding at least the principles of neurology and the anatomy of the central nervous system, knows what can be done and what cannot be safely done surgically and in this manner the catastrophes of the past are being avoided. If the condition of the patient cannot be benefited by the operative procedure, the surgeon should by no means make the condition worse. The third factor has been an improved surgical technic whereby the operative mortality has been greatly lessened so that the risk is no greater than that of a major operation in general surgery; the duration of the operations has been lessened almost 50 per cent., the greatest care and attention being given to hæmostasis, and in recent years the use of local anæsthesia for almost all of the operations upon the central nervous system; local anæsthesia not only perfects the hæmostasis, but it lessens the operative shock and this method should be used in every adult case whenever possible.

The neurological conditions amenable to surgery may be divided into two fields according to the end-results obtained—not only the operative result as to life and death, but rather that of ultimate recovery of function, whether the individual becomes a useful member of society again, is able to earn a living, and may be considered as normal after the operative treatment as before the lesion developed. In this respect, the majority of the conditions comprising the field of neuro-surgery are very different in their end-results from the conditions of general surgery, such as in abdominal lesions; the diseased appendix or the infected gall-bladder can be removed and the patient not only regain his former health, but very frequently achieve much better condition of health than before the lesion was suspected, whereas in most of the conditions in neuro-surgery, rarely is the lesion diagnosed early and accurately localized to a degree warranting an operative procedure until long after delicate nerve cells and tracts have been irreparably damaged, so that even with a successful operative removal of the lesion yet the end-result is at most an improvement—by all means a result to be desired and strived for, but rarely can the word "cure" be used; when such a happy result is achieved therefore, it is usually heralded and such cases are reported in the literature to an extent that these successful results are considered much more common than is the case, and indeed it is most rare for a patient having had a neuro-surgical condition to regain his former normality—the chief exceptions being operative cases of trifacial neuralgia, many acute brain injuries, and early peripheral nerve injuries. Besides, many neuro-surgical lesions cannot be removed—the object of the operation being merely to offset the results of the presence of the lesion rather than the elimination of the lesion itself and naturally in these cases an improvement is the most to be expected.

Discouraging Field.—In my series of cases during the ten-year period of 1913–1923, the most discouraging field in neuro-surgery consists of brain tumor, brain abscess and the condition of internal hydrocephalus.

1. *Brain Tumors.*—The discouraging feature of these conditions is not the operative risk as it is the high degree of malignancy of these tumors—not so much to the extent of producing metastases as to their recurrence upon removal and eventually causing the death of the patient. In my series of brain tumor cases, 81 per cent. have been malignant, and of my last 14 cases, 12 have been malignant—the 2 benign tumors being, as the first of this series, an endothelioma, the size of an orange, in a twenty-one months' old baby, already blind with a secondary optic atrophy of high intracranial pressure and the last of this series being a large right frontal lobe endothelioma in a man of fifty-four years of age having had convulsive seizures for sixteen years and definitely deranged mentally, so that at most a useful member of the community could not be expected. At present, I have no patient living over three and one-half years following the removal of a malignant cerebral tumor. Even if the tumor is diagnosed early and accurately localized and the tumor should be a benign one, it is only too frequent for such a tumor to be located intracranially in an almost inaccessible situation surgically and in order to remove such a tumor, normal brain tissue must frequently be penetrated and damaged at the time of the operation, so that even should the patient recover from the operation, yet a normal individual cannot be expected—physically, mentally and emotionally. The excellent contribution by Dandy of ventriculography is a most important one, and it does make possible the accurate localization of tumors impinging upon the ventricles by röntgenograms of the injected air; unless the tumor is a small one and closely associated with the ventricles and therefore a deep subcortical one, then the other tumors in order to dent the ventricles must be large if they are to reach the cortex; they must therefore have been in existence for at least months, and even though these tumors are benign and are successfully removed, rarely is it possible to obtain a normal individual. In my experience, if tumors of the motor areas and the auditory nerve fibromata of the cerebellar-pontine angle are excluded, brain tumors at operation are, with few exceptions, large brain tumors and tumors not arising from the dura and the meninges—that is, the cortical and subcortical "true" brain tumors, are invariably malignant tumors; the meningeal endotheliomata of benign character are in reality only brain tumors to the degree of compressing cerebral tissue and are in no way comparable to the seriousness of cerebral tumors. It is fortunate, however, that earlier diagnosis is now possible in these cases, and it is becoming less and less frequent for patients to be referred to the surgeon after vision has been destroyed and the patient has become extremely impaired, both mentally and physically; the more common use of the ophthalmoscope and the accurate measurement of the pressure of the cerebrospinal fluid at lumbar puncture by means of the spinal mercurial manometer together with the findings of ventricular estimation and cisternal punctures—all these methods of intracranial diagnosis have been added to the neurological armamentarium to the great benefit of patient. The operative mortality has been 19 per cent,

2. *Brain Abscess.*—This is another discouraging condition and chiefly due to the high mortality; without operation, the mortality practically is 100 per cent., so that the treatment is a surgical one, and yet even with the operative treatment, and even if the cerebral abscess is located (and almost all operations for cerebral abscess are in reality exploratory procedures) and drainage instituted, yet the mortality rate in my series of cases has been 72 per cent. In this connection, I wish to differentiate a "true" brain abscess (one within the cortex or subcortical, and the only ones that can be really termed brain abscess) from the subdural collections of pus so frequently associated with otitic and mastoid disease and well walled-off from the cerebral cortex itself in the form of a localized purulent meningitis; to consider this latter condition as brain abscess is very misleading—its treatment is a simple incision of the dura and the mortality rate is justly a low one, so that to include this type of subdural abscess among those most serious conditions of "true" brain abscess is very confusing and accounts for the low mortality statistics so frequently reported in the literature—from 48 per cent. down to even 26 per cent. mortality! A definite advance in the surgical treatment of brain abscess and particularly of that most common type of temporo-sphenoidal abscess associated with otitic and mastoid disease is the avoidance of opening the dura through the infected field of the mastoid into the non-infected subarachnoid spaces and cortex in exploration of the location of the abscess and, if the abscess is not found, then the great danger of producing a purulent meningitis; it is a much more rational procedure to locate the suspected supratentorial abscess—its most common site being in the comparatively "silent" temporo-sphenoidal lobe adjacent to the otitic infection, by means of a dural incision through the clean subtemporal route, so that if the abscess is located, it can then be drained through this incision as well as through the mastoid area; and if the abscess is not found, then the patient has not been subjected to the great danger of a purulent meningitis. Besides, the subtemporal decompression will relieve the associated cerebral œdema and will even permit and facilitate the "pointing" of an overlooked abscess toward the subtemporal dural opening.

3. *Internal Hydrocephalus.*—Possibly the most discouraging field in neuro-surgery has been the attempts to treat successfully the condition of internal hydrocephalus—a complete blockage of the ventricles either in the aqueduct of Sylvius or at the posterior foramina of Majendie and Luschka of the fourth ventricles by the exudate of a former meningitis or more rarely by the organization-residue of unabsorbed basilar hemorrhage occurring most frequently at the time of birth. To overcome this mechanical blockage of the escape of the cerebrospinal fluid from the ventricles and the avoidance of the resulting ventricular dilatation with its cerebral destruction has been attempted ever since Aristotle first performed ventricular punctures through the open fontanelle as a temporary relief of the condition and with no more success than is now being obtained in this complete type of internal hydrocephalus. One operative method after another has been reported as a "new"

method of treatment and frequently only one case reported as having been so treated—and yet the end-result has invariably been the same—the death of the patient. Besides, by the time the condition is diagnosed clinically, the ventricular dilatation has produced such irreparable cerebral damage that even if the operative treatment were successful in removing the mechanical blockage, yet a normal individual is not conceivable. Fortunately, however, the cases of hydrocephalus so diagnosed are rarely of the complete internal type—in fact, over three-fourths of the cases in my series are the external type—there being no blockage of the ventricles but a blockage of varying degree in the absorption of the cerebrospinal fluid through the walls of the supracortical veins—almost 80 per cent. of the cerebrospinal fluid being excreted in this manner and the remainder by means of the sinuses, Pacchionian bodies, etc. This latter condition of external hydrocephalus is frequently due to a former supracortical hemorrhage occurring commonly at the time of birth, and it is this milder type of external hydrocephalus that can be markedly improved by early operative drainage of the blocked cerebrospinal fluid and thus lowering the increased intracranial pressure.

Encouraging Field.—Fortunately, the encouraging field of neuro-surgery consists of the larger number and of the more frequent neurological conditions amenable to surgery.

1. *Trifacial Neuralgia.*—The operative treatment of trifacial neuralgia, after other methods of treatment have failed, is possibly the most gratifying in that the severance of the posterior sensory root of the Gasserian ganglion or the extirpation of the ganglion itself affords immediate and permanent relief; merely severing the second and third branches of the trifacial nerve intracranially at their foramina of exit is of temporary value only and is never performed unless operative complications make it advisable to do so. The mortality in my series has been 2 per cent. and is the lowest of all cranial operations—being in reality an extradural procedure.

2. *Spinal Cord Lesions.*—A. Tumors affecting the spinal cord have been malignant in only 41 per cent. of my series. Since the diagnosis of spinal cord tumor is comparatively much earlier and the localization more accurate than cerebral tumors, it is frequently possible to obtain an apparently normal individual in the benign cases; no patient in this series is living, however, having had a malignant tumor removed over five years ago. As in cerebral tumors, true spinal cord tumors—that is, ones arising in the substance of the spinal cord rather than in its covering, are with few exceptions malignant. Only in early cases of small tumors of the meninges where the compression of the spinal tracts has not been prolonged and severe, has it been possible to obtain normal gait and sensation, and the reflexes within normal limits. The operative mortality has been 9 per cent.

B. Traumatic lesions of the spinal cord usually associated with vertebral fracture are amenable to marked improvement if there is not present a primary contusion and laceration of the spinal tracts. Spinal cord compression of bone and of extensive hemorrhage should be relieved early for fear

of permanent damage to the tracts. If it is definitely known that the signs of an acute transverse myelitis are due to irreparable contusion, laceration and even severance of the spinal cord and thus a hopeless condition, naturally surgery offers nothing to these patients; but if it is not known definitely that the cord is irreparably damaged, then it is my opinion that these acute patients should be given the benefit of an exploratory laminectomy of spinal decompression and drainage after the shock has subsided; to wait for a period of months in these cases and if sensation returns to the legs or some motor power, then to advise an exploratory laminectomy is merely months late—the ideal time for treatment, as in brain injuries, is during the acute stage and not during the chronic stage, when the improvement, if any, to be obtained becomes less the longer the interval following the injury. In none of these chronic cases has more than a slight improvement been possible. The operative mortality in these acute patients has been 16 per cent.

3. *Peripheral Nerves.*—A. In the surgery of traumatic lesions of the peripheral nerves, the best results have been obtained in the end-to-end anastomoses as soon as possible after the severance, that is, the emergency operations. The greater danger of infection in these cases is more than offset by the excellent end-results as compared with the chronic cases. The farther from the spinal cord the anastomosis, the better has been the end result, and yet it was rare to obtain a complete recovery of sensory and motor functions in the chronic conditions. Local anæsthesia has been used and there has been no mortality.

B. Traumatic lesions of the brachial plexus occurring at the time of birth are apparently due in a large percentage of the cases to a simple overstretching of the nerve roots of the plexus, so that an early complete recovery of function is possible within three to six months after birth. But in those cases where one or more branches of the plexus are torn and their ends separated, then in many of these cases at least a recovery of function does not occur and the earlier the end-to-end anastomosis is made, the more complete the end result. In my series of 146 operated cases with a mortality of one, there is not one case of complete recovery of function—that is, the affected arm being as normal as the other arm, although the earlier the anastomosis after birth, the better has been the end result. The ideal age for the operative repair is at three months.

C. Chronic peripheral facial paralysis due to otitic and mastoid complications, local trauma and chronic cases of the Bell's type, may be improved in selected cases of complete paralysis by the anastomosis of the ipsolateral hypoglossal nerve or better one-half of it to the distal end of the facial nerve as it emerges from the stylo-mastoid foramen. My best result has been only an improvement in the facial musculature and movements—by no means a perfect result. There has been no mortality in 32 cases. Direct anastomosis of the facial nerve itself or the separation of adhesions compressing it in its bony canal, may be attempted in selected cases.

4. *External Hydrocephalus.*—These conditions of supracortical obstruction

in the circulation of the cerebrospinal fluid, not in the ventricles of the internal type, but at the sites of absorption or excretion of the cerebrospinal fluid through the walls of the supracortical veins, sinuses, Pacchionian bodies, etc., and thus producing the chronic condition of so-called external hydrocephalus under varying degrees of increased pressure, may be improved by cranial drainage of the partially blocked cerebrospinal fluid. The degree of improvement depends upon the severity of the initial lesion, whether the blockage is due to a diffuse meningitis and meningo-encephalitis in which the prognosis is naturally bad or due to an extensive supracortical hemorrhage with little or no primary damage to the underlying cortex. If, by cranial drainage of the blocked cerebrospinal fluid, the increased intracranial pressure can be lowered to normal, then it is possible for a large percentage of these cases to be improved and the younger the child, the greater is the improvement to be obtained. My series contains 93 of these patients with a 12 per cent. mortality.

5. *Acute Brain Injuries.*—A. *Adults.* The diagnosis and treatment of acute brain injuries form in my series of neuro-surgical conditions the most satisfactory cases from the standpoint of the end-results to be obtained. A few years ago, these conditions were termed " fractures of the skull," and this comparatively unimportant bony pathology has retarded the diagnosis and the rational treatment of brain injuries for many years—the important findings now being the presence or not of a high intracranial pressure of hemorrhage or of cerebral œdema. Gross laceration of cerebral tissues was not a frequent post-mortem finding in my series—6 per cent. only, whereas supracortical hemorrhage and cerebral œdema were most common. In this series of acute brain injuries in adults, now over 1000 cases, the expectant palliative treatment was satisfactory in over one-half of them—56 per cent.—there being no marked increase in the intracranial pressure, at least not over twice the normal, and where the expectant palliative treatment of absolute quiet, ice helmet, shock measures, etc., sufficed, aided in selected cases having a mild increase of the intracranial pressure by repeated lumbar punctures of spinal drainage. The use of magnesium sulphate and sodium chloride solutions to lower high intracranial pressure in these traumatic cases has not been satisfactory in my series, but it has been of great value in the chronic cerebral œdemas associated with tumor formations, etc.; this latter condition is more a true intracellular œdema rather than the " wet " œdematous condition of the brain so frequently present in the traumatic cases. The operative treatment to lower an increased intracranial pressure was deemed advisable in only 30 per cent. of the cases—only when a marked depression of the bony vault was present or when the intracranial pressure was over twice the normal—above 16 mm. of mercury. The total mortality was 39 per cent. and if we subtract the 14 per cent. of moribund cases—those patients entering the hospital and dying within six hours after admission from shock, medullary œdema (decompensation), other internal injuries and for whom no operative treatment was naturally advised, then the mortality is lowered to 19 per cent. The operative mortality was 38

per cent., and these were the patients more seriously injured not only from the standpoint of recovery of life, but of future normality.

In the operative treatment of acute brain injuries, there are two periods in which *no* operation should be performed, and it has been the neglect of this fundamental consideration that the operative treatment of selected cases of brain injuries had become almost discredited. The first period in which no operation should be performed is during the initial stage of shock, when the temperature is subnormal and the pulse and respiration rates are above 120 and 34, respectively, and the blood-pressure below 100. To advise a cranial operation or even extensive prolonged examinations and tests upon these patients in the condition of severe shock merely lessens the chances of recovery, and if the patient does survive, then he recovers in spite of the additional shock of the examination and of the operation.

The second period during which no operation should be performed may be termed the terminal one of medullary œdema (decompensation), characterized clinically by rapidly increasing pulse and respiration rates and rising temperature, but by a falling blood-pressure. The patient may have been "doing well" for a period of several days and then he changes rapidly, so that the picture approximates the clinical syndrome as described above and then, since it is feared the patient will die, it is often thought advisable "to give him a chance;" but these patients all die, having the condition of medullary œdema, whether operated upon or not—the operation merely hastening the exitus.

However, in the treatment of patients having acute brain injuries, their intracranial status can be accurately estimated by repeated lumbar punctures, using the mercurial manometer and by frequent ophthalmoscopic examinations and in this manner the late clinical signs of medullary compression, such as retarded pulse- and respiration-rates and a possible increasing blood-pressure, can usually be anticipated and thus the dangerous condition of medullary œdema be prevented by the rational treatment of early subtemporal decompression and cranial damage in that small percentage of selected cases having a high intracranial pressure (less than one-third of all cases). The use of repeated punctures of the cisterna magna for the drainage of subtentorial hemorrhage with definite signs of medullary compression may be of great value in selected cases.

B. *Children.*—The diagnosis and treatment of acute brain injuries in children under sixteen years of age are the same as in adults, except that the operative method of treatment to lower a marked increase of the intracranial pressure due to hemorrhage or to cerebral œdema is much less frequent, owing to the fact that acute cerebral œdema following cranial injuries in children occurs comparatively rarely. Apparently the intracranial vascular mechanism of the child adjusts itself much more rapidly and easily to the effects of cranial trauma, so that an increased amount of cerebrospinal fluid is either not secreted or, if secreted in large amounts, then the excess is absorbed without difficulty, so that the condition of acute cerebral œdema only occurs in the

extreme cases. For this reason, the operative treatment of acute brain injuries in children has only been necessary in 16 per cent. of the patients, whereas in adults the operative treatment was advised in 30 per cent. It may be stated also that children will stand the effects of brain injuries much better than adults, and I believe this is also due to the less frequent occurrence of extensive cerebral œdema in them.

C. *Newborn.*—For years the acute condition of intracranial hemorrhage of the newborn has been a pathologic study of post-mortem findings rather than their clinical recognition and, therefore, limited to a consideration of gross lesions and of extreme forms of intracranial hemorrhage of sufficient amount to cause the death of the baby. One hundred years ago, Denis, Billard and Cruveilheir wrote that one-third of the deaths of the newborn were due to intracranial hemorrhage. After Little described his findings, in 1862, and McNutt, in 1885, confirmed this opinion of the relationship of intracranial hemorrhage of the newborn and cerebral spastic paralysis, very little attention to this subject of intracranial hemorrhage in the newborn was given in the literature, until the last decade when a greater interest has been aroused. Numerous investigators of the post-mortem findings, particularly Warwick, Capon and others, have stated that at least 50 per cent. of the deaths in the newborn were due to a gross intracranial hemorrhage, resulting from a rupture of the tentorium, falx, large sinuses, and of the supracortical tributaries of the longitudinal sinus, etc. And then the clinical observations of Sidbury, Brady, Green, and others, have added to the clinical picture of a condition, the recognition of which, Huenekens states, is the most neglected phase in the care of the newborn and yet the most important one.

During the ten-year period of 1913 to January 1, 1923, I had the opportunity of examining in consultation and treating 46 newborn babies within the first two weeks, the diagnosis being a serious intracranial lesion, most probably hemorrhage following a difficult labor, with and without the use of instruments. The acute condition of these children was considered of such grave character that early death was feared and it was hoped that possibly a cranial operative procedure might offer the child a chance of recovery of life, at least. Lumbar punctures were performed on all but two (these two having died before tests could be performed) and free blood, under varying degrees of increased pressure was found in the cerebrospinal fluid of 87 per cent. of these patients, tested during the first week after birth. During the second week, and especially later, the lumbar puncture becomes of increasingly less value as a diagnostic aid, the fluid blood usually coagulating within the first ten days. Repeated lumbar punctures of spinal drainage were used in four of the milder and earlier cases within the first week, with the hope that the intracranial hemorrhage could all be drained in this simple and safe manner, but in only two of them, after four and seven lumbar punctures, respectively, every twelve hours, did the fluid become clear and of normal pressure.

This method of spinal drainage should be attempted in all but the very extreme cases of extensive intracranial hemorrhage, under high pressure,

within the first week after birth. If the cerebrospinal fluid does not become clear or the pressure become normal and remain normal, then the cranial operation of modified subtemporal decompression and drainage should be considered. The operative and post-mortem findings in 100 per cent. of these acute extreme cases disclosed subdural, supracortical and subarachnoid hemorrhage of varying degree. If not of sufficient amount to cover the convolutions, then the free blood was found in the sulci about the supracortical veins and always associated with a high degree of cerebral œdema. Of these 46 cases, 29 died with and without operation. Seventeen babies lived, and of these 8 are now apparently within normal limits, physically and mentally, whereas 9 are definitely impaired both physically and mentally; of these 9 children, 6 were operated upon during the second week and 3 upon the fourth, fifth and seventh days, respectively. It must be remembered that these were serious cases of extensive intracranial hemorrhage and were not operated upon until several days later, when it was considered that the baby was going to die; the ideal time, as we now know, for the spinal drainage of repeated lumbar punctures is as soon as possible after acute intracranial condition is definitely diagnosed.

In this connection, it may be of interest to record the frequency of intracranial hemorrhage of varying degree in the newborn as registered by routine lumbar punctures within twenty-four to forty-eight hours after birth in a series of 500 consecutive newborn babies at the City Hospital, Manhattan, during the past two years.* These observations were made with my associate, Dr. A. S. Maclaire, and it was most surprising to find bloody and blood-tinged cerebrospinal fluid in 45 babies—that is, in 9 per cent. Repeated lumbar punctures of spinal drainage were made until the cerebrospinal fluid became clear and under normal pressure—the average number being three punctures. Three of the babies died and each autopsy disclosed supracortical hemorrhage and cerebral œdema of varying degree. Less than one-half of these babies evinced signs indicative of an intracranial hemorrhage; the signs, when present, were drowsiness to stupor, difficulty to refusal to nurse, and twitchings of orbital muscles and fingers to general convulsive seizures. The blood-clotting time was not lengthened in a single case, so that the factor of hemorrhagic disease of the newborn, in this series at least, seems almost a negligible one, unless in its so-called "latent" form, whereas both trauma and asphyxia are apparently the more common etiological factors.

Chronic Brain Injuries.—A. *Adults.* It has become quite a common expression among the laity, that "once a person has had a fracture of the skull, then that person is never the same again." To a large extent this impression is a correct one, at least it was so during the period of over ten years ago, when the attitude of the medical profession was concerned merely with the recovery of life of the patient rather than the return to complete functional normality. In the absence of gross cerebral lesions of the brain

* These observations were presented to the American Medical Association at its meeting in Atlantic City, in May, 1925, and will be published in detail in the *Journal of the American Medical Association.*

as a cause of death in a large series of consecutive autopsies of patients dying from cranial injuries during the four-year period of 1912 to 1916 in Bellevue Hospital, and the demonstration in these cases that the usual findings were "wet" œdematous brains associated or not with varying degrees of hemorrhage along the sulci about the supracortical veins, it was most interesting to study the clinical records of four of the large hospitals in New York City of their patients having had cranial injuries during the decade of 1900 to 1910. The total mortality ranged from 46 to 64 per cent., the operative mortality being as high as 87 per cent., due to the operation being performed during the two periods when *no* operation should be even considered.

This study was made in the year 1912. Only 34 per cent. of the patients discharged as "well," "cured" and "improved" were located, but of these patients 67 per cent. were not well and were still suffering as the result of the cranial injury, the chief complaints and signs being headache, dizziness, early fatigue, change of personality to the depressed or irritable type and in a small percentage of them convulsive seizures. It was rather surprising to find in a large percentage of these patients evidences of an increased intracranial pressure, as disclosed both by the ophthalmoscope and by the lumbar puncture, and thus indicating the chronic condition of cerebral œdema. At operation even at this late date after the injury or at autopsy, there was disclosed an œdematous, "wet" brain under varying degrees of increased pressure and along the supracortical veins in the sulci was exposed a cloudy, whitish new-tissue formation—the organization-residue of a former layer of supracortical hemorrhage which could not be absorbed through the normal channels of excretion—the stomata of exit in the walls of the supracortical veins, through which almost 80 per cent. of the cerebrospinal fluid is normally excreted. It is this organization-residue which causes a partial blockage in the normal absorption of the cerebrospinal fluid, and thus the resulting "wet" œdematous brain under varying degrees of increased intracranial pressure—the organic basis for many of the symptoms and signs occurring in patients having had a cranial injury, as headache, dizzy spells, early fatigue, change of personality and even convulsive seizures themselves, all of these symptoms and signs being due to cranial pressure rather than to a gross cerebral lesion, such as lacerations, cortical hemorrhage, etc.

Post-traumatic Neurosis.—In this connection of chronic brain injuries, the condition of post-traumatic neurosis is one that must always be considered—a functional condition to be differentiated from an organic one. In post-traumatic neuroses, the emotional factor of fear and shock at the time of the injury is to be remembered, together with the constitutional make-up of the patient, whether neuro- and psychopathic or not; and also in a large percentage of these cases, the factor of hope of damages to be obtained, this latter complication being frequently an all absorbing one. If a legal suit is pending, it is not possible to improve the condition of these functional cases by any known method of treatment; after the suit is settled, and especially if satis-

factory to the patient, these are the patients having functional conditions which improve very rapidly and usually within months or one year following the injury. However, no such patient should be considered as having a functional condition of neurosis without careful neurologic examinations having been made, and in each case competent ophthalmoscopic examinations and a lumbar puncture with an estimation of the pressure of the cerebrospinal fluid as registered by the spinal mercurial manometer, so that it is definitely ascertained that there is present no increase of the pressure of the cerebrospinal fluid. Otherwise the patient, having an increased intracranial pressure of chronic cerebral œdema and thus an organic basis for the symptoms and signs, may be incorrectly diagnosed, for these patients having organic lesions do not "clear up" and improve following a mere satisfactory settlement of the legal suit. These organic cases are ones now being frequently overlooked and neglected under the classification of post-traumatic neurosis.

B. *Children.*—In 1913, I became interested in the chronic condition of cerebral spastic paralysis and, in taking careful histories of a large series of patients at two of the orthopædic hospitals of New York City, and then by thorough neurologic examinations including the routine ophthalmoscopic and lumbar puncture tests, it was surprising to note that in a small percentage (12 plus per cent.) of these patients there were evidences of an increased intracranial pressure of chronic cerebral œdema. Occasionally, in a very small number of the older patients, the X-ray disclosed evidences of convolutional markings of the inner table of the vault, due to its atrophy resulting from the prolonged increase of the intracranial pressure.

The history of these chronic patients having the condition of cerebral spastic paralysis is rather instructive. During the past ten years, up to January, 1923, I have examined personally 5192 children, and of this total number examined, 671 (12 plus per cent.) have had an increased intracranial pressure as disclosed at lumbar puncture. The operative and post-mortem findings have revealed "wet" œdematous brains under varying degrees of increased pressure, and along the supracortical veins in the sulci was a whitish cloudy new-tissue formation, reported pathologically as being the organization-residue of a former layer of hemorrhage which had occurred most probably at the time of birth. Gross cerebral lesions of intra- and subcortical hemorrhagic cysts, old cerebral lacerations, etc., were disclosed in only 6 plus per cent.

The histories revealed the following data: 81 per cent. first children; 72 per cent. males; 95 per cent. full-term babies; 90 per cent. difficult labors; 76 per cent. forceps used as last resort; 17 per cent. breech deliveries; in 8 per cent. pituitrin had been used.

During the first week, the following observations had been made: 64 per cent. more drowsy and stuporous than normally; 23 per cent. refused to nurse, 78 per cent. evincing a lessened normal demand for food; 39 per cent. muscular twitchings, especially of orbital muscles and fingers; in 17 per cent.

general convulsive seizures occurred; in 18 per cent. an icteroid appearance was present.

Within two weeks after birth, 61 per cent. were considered well and normal, if indeed anything abnormal had been suspected. Within one month after birth, 82 per cent. were considered normal.

Within the first year and usually around the seventh month after birth, 79 per cent. of the children were not developing as they normally should, such as holding up the head and later beginning to sit up, and at this time, within the first year, the development of spasticity of varying degree and type was usually observed. Later the child did not walk or learn to talk within the usual time, and it was this development of a chronic condition in an apparently normal child that was most mysterious, to say the least, and its presence was ascribed to almost every possible cause. In this connection, I may state that the Wassermann test of the cerebrospinal fluid was positive in only one-half of one per cent.

Treatment.—The treatment of this chronic condition of cerebral spastic paralysis depends entirely upon the presence or not of an increased intracranial pressure: (a) Without a definite increase of the intracranial pressure and, therefore, the cerebral damage having already occurred, the treatment is limited to the various orthopædic measures and to mental training. To lessen the spasticity, numerous peripheral nerve operations have been devised, and recently even the severance of the paravertebral sympathetic ganglionic chain—an operative procedure of no real value in my six cases. (b) With a definite increase of the intracranial pressure, if this increased pressure is not over twice the normal (the normal being 6–8 mm. Hg.), thyroid and thymus therapy may be tried in the hope that this mild increase of the intracranial pressure can be lowered to normal by lessening the amount of the cerebrospinal fluid secreted. However, if the increased intracranial pressure is over twice the normal, the operation of subtemporal decompression and cranial drainage may be considered, in the hope that a sufficient amount of the blocked cerebrospinal fluid can be permanently drained in this manner and thus a definite lowering of the increased intracranial pressure be effected with a resulting improvement of the child's condition, both physically and mentally.

The operative and post-mortem findings in these selected chronic cases of cerebral spastic paralysis have been practically the same as disclosed in the chronic cases of brain injuries which have occurred in adults and in young children, and the original pathology is apparently the same in these cases—a supracortical layer of hemorrhage of greater amount than can be normally absorbed through the walls of the supracortical veins; its collection in the sulci about the supracortical veins and the subsequent formation of an organization-residue of the hemorrhagic clot and thus the resulting partial blockage in the normal absorption of the cerebrospinal fluid, producing "wet" œdematous brains under varying degrees of increased pressure. The younger the child at the time of the development of this increased intracranial pressure, and particularly, therefore, those cases due to an intracranial hemorrhage at the time of

birth, the greater will be the physical and mental retardation and the more marked the condition of spastic paralysis and mental retardation. The older the patient at the time of the intracranial hemorrhage, as in adults, the less marked are the gross physical and mental impairments, but the more marked are the subjective complaints, such as headache, dizziness, early fatigue and changes of personality and the greater are the emotional and psychic impairments.

The prognosis in the treatment of these chronic patients depends chiefly upon the age of the patient and the severity of the intracranial lesion. The younger the child at the time of the lowering of the increased intracranial pressure, the greater the improvement to be expected, but not one of these chronic patients can be expected to become normal as though the hemorrhage had never occurred, no matter what the treatment, because the treatment of these chronic conditions is always a late treatment. The ideal time for the treatment of brain injuries of the newborn, just as in brain injuries of adults, is at the time of the acute condition, when the intracranial hemorrhage itself can be drained—in the adults after the period of initial shock has subsided and in the newborn within a period of one week.

SURGICAL TREATMENT OF EPILEPSIA PARTIALIS CONTINUA (KOJEVNICKOVI)

By N. J. Beresnegovski, M.D.
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Epilepsia partialis continua was described for the first time in 1894, by Professor Kojevnickov, and at the same time by Professor Bruns under the name of myoklonia cum epilepsia. The greater number of cases of epilepsia partialis continua has been described by Russian medical men—less by foreigners. This malady can be frequently met in Siberia. Thus Professor Omorokov described 27 cases, which were observed in Tomsk's clinics during three years, while in the medical literature of the world up to 1922 there were described only 12 cases.

The main symptoms of this disease are: (1) Continual excitement, which is expressed in continual convulsions and (2) a local affection, manifesting in convulsions confined to particular groups of muscles, which convulsions do not extend to the other groups.

The pathology of this disease is not completely explained up to the present time. Choraschko and some foreign authors found some changes in the subcortical substance of the brain, while others, Kojevnickov, Omorokov, think that the primary changes are in the cortical substance.

In isolated cases of this disease some authors found affection of a specific character, thus syphilis (Strümpell), tuberculosis and cystocercus (Omorokov). In the greater number of cases some authors found changes in the form of organic inflammation—encephalitis in different stages of development.

According to the materials received after operations, which were performed in the Chirurgical Clinics of Tomsk University, Professor Omorokov gives a detailed account of microscopical changes in the cortex in this disease.

It is observed that the blood-vessels in epileptics suffer very much. Their walls become thicker, they are infiltrated by lymphocytes, leucocytes and plasmodium cells; the endothelium becomes dilated and in many parts contains vacuoles. The cortex of the brain becomes thinner and sclerosed. Ganglion cells in some cases become dilated, the nuclei of these cells have eccentric positions, Nissl's bodies become separated—in other cases cells are small and their nuclei fall to pieces.

There is observed a great development of glia tissues, presence of many giant cells with various inclusions in them. Nerve fibrils are found to be in different kind of degeneration with the necrosis of myelin substance.

In the nerve tissue there are a great many products of regressive metamorphosis of different kind of lipoid changes. The progress of the malady is limited. Inflammation is situated only in one locus, as in adjoining places

is found healthy nerve tissue. No specific microbe has been found for Kojevnickov's epilepsy.

It is a very interesting fact that this disease is met very often in the north of Siberia, while in Europe it is comparatively rare. Village inhabitants are chiefly attacked with this disease. Probably the cold climate of Siberia plays some part in the etiology of it. Young persons, not older than thirty years of age, are chiefly affected.

Hereditary syphilis is often marked and alkoholismus. Recent syphilis usually is not found. The Wassermann test gives negative results.

The beginning of the illness is usually acute. The temperature suddenly rises. The patient falls into an unconscious state. If the illness does not end by death and the person recovers—attacks of epilepsy appear in different forms. In one class of cases after the acute period there are paralyses of some parts of body, which gradually become feebler, while convulsions of particular groups of muscles begin to develop.

In other cases local convulsions appear suddenly after the acute period. And in a third group of cases the patients, after the acute period, seem to be recovered from illness, but after some time convulsions appear. Sometimes local convulsions are preceded by the general attacks of convulsions of epilepsy.

The main symptoms of Kojevnickov's epilepsy are continual convulsions of particular groups of muscles. As, for example, convulsions confined to one of the limbs. Seldom are convulsions observed in a larger part of body, as half of it. But if the latter happens, still, we can observe convulsions in particular groups of muscles of it. This shows the localization of the process. If the convulsions begin they do not stop even when a person is asleep. During psychic stimulation, as when some one draws attention to a patient or when a medical examination is taking place—the convulsions are usually exacerbated. When a patient is calm the convulsions grow less strong. These continual convulsions exhaust the person very much. To smoothe them a little patients resort to different kinds of forcible measures. Thus: a patient seizes with a healthy hand the ill one; if the convulsions attack a leg, the patient crosses his legs and presses strongly the ill one with the healthy one. In the most cases the convulsions are accompanied with pain.

In spite of the strenuous work of the muscles of the affected limb, not very seldom we can notice atrophy of them. For example, in one of our cases the thickness of a healthy shoulder was 28 cm. while the ill one was 21. The difference seems to be a great one. Pain from the sting of a pin and the sensation of touch do not suffer in this disease. Sometimes arbitrary pains in the ill limb are observed.

The local convulsions periodically change into total convulsions of epilepsy. The frequency and the quality of the convulsions are not the same in many cases. In some cases they occur once or twice a month, in others sometimes every day. The psychic of patients in most cases is lowered.

The treatment of a patient with epilepsia Kojevnickov may be thera-

peutical as well as surgical. In therapeutical treatment the administration of preparations of bromium sometimes lowers the convulsions. The giving of hydrargirum does not do any better.

Therefore, the surgical treatment is left for us. The latter is used in two forms: as a decompression operation and for removal of cortical centres. A decompressional operation we undertook in one case of Kojevnickov's epilepsia, where the convulsions were expended on the right upper and the lower limbs and on some parts of the face and neck, and moreover total convulsions of epilepsia often were observed. The convulsions in this case were distinctly manifested in the right hand; here we could notice feeble convulsion on the left side of the face about musculus orbicularis. Of course in such a case we could not possibly rely upon the radical recovery after removal of all cortical centres. It would be necessary to remove all motor centres in the left hemisphere. In this case we determined to confine ourselves to a decompression operation by making an aperture in the cranium. In the regio temporalis of the left side of the cranium a semicircular incision was made. The bone and dura mater were removed to the extent of 3 x 3 cm. The skin and muscles flap was then closely sewed up.

The post-operation period ran smoothly. The convulsions became feebler, the total attacks of convulsions become somewhat more rare. But such periods of temporary improvement had been observed before the operation. Therefore it is very difficult to say whether the operation itself brought any improvement.

The second more radical way for operation is removal of cortex centres.

The meaning of this last operation is different according to what theory of localization of process from pathological sight of view, we adopt, whether to that of Choraschko, who thinks that the process is placed in the subcortical substance or to that of Kojevnickov's, who thinks that in this illness the cortical substance is affected. In the first case by removing cortical centres, we break up motor apparatus and therefore destroy that battery which sends impulses for convulsions. Breaking up the apparatus we stop convulsions though we do not remove the affected place. In the second case, removing the cortical centres we remove the affected places; therefore from this viewpoint the indication for operation is complete.

There is undoubtedly an indication for removal of cortical centres, where at the base of the illness there is a cystocercus, seated in the cortex, as we observed in one case (No. 2). Here the removal of the cystocercus is the removal of the cause of the illness. The technic of trepanning is well known to every one, and so I shall say few words about some details of it.

The direction of Roland's fissure was determined by the well-known methods. It was marked with a line of nitrate of silver. Such a line does not disappear after applying to the skin tincture of iodine. Hemorrhage from the vessels of the skin was stopped by Heidenhain's method. A piece of bone in form of quadrangle, 6 x 8 cm., is cut big enough to examine the suspected locus. We use Doyen's phrese and Dalgren's tongs. A hammer and

chisel we never use. The dura mater we open in the form of the letter H. By such a form of opening the dura mater we do not wound sinuses. The transverse cut is made in space entirely free from bone. It is necessary to be careful when continuing a cut upwards not to wound the longitudinal sinus. If, by any case happens such a misfortune, particularly when the lateral branches of the sinus lie very far away, it would be necessary to put in a suture. If these cut through, we have used in three cases with success, a tamponade with piece of muscles. The arachnoid veins we tie with fine ligature.

The epileptogen zone was located by bipolar electrodes after the method of Rasosmoskii. Muscular convulsions as a reaction in the affected limb were very rare. There was no one case in which we could not localize an epileptogen zone by this method. We never excite in using it a total epilepsy.

Further, we note the boundary of this zone. This place on the cortex we mark by a scalpel and remove it in a whole piece, simultaneously removing cortical substance, lying deeper in the sulci of the brain. After removing the piece we examine again adjoining places and the bottom of the wound whether any parts of cortex remain. If such parts are discovered, we remove them with a sharp curette or a scalpel. It is necessary to give special attention to the removal of all affected portions of cortex. If this is not done, in course of time it would be necessary to re-operate, as was observed in Prof. V. N. Sabrin's case (Omorokov).

It is not easy to reach the foot centre that lies on the very summit of the brain and goes behind the internal side of the hemisphere, lying near to the lateral and central part of the longitudinal sinus. Thus Professor Misch (Tomsk) in one case of athetos could not remove the whole centre of the lower limb and therefore he made other operations on peripheral nerves, dividing them.

For removing the feet centres we use the following method: So that not to open the longitudinal sinus, the cut in the dura mater should not extend beyond 1 cm. from the middle line. Then in the dura mater and its processus falciformis we apply a wide retractor, with which we expose the brain and proceed to cut out the superficial portion of the cortex, and deeper between both hemispheres. When examining the centres with the electrodes, care should be taken not to make contact with a retractor.

To transplant pieces of fat on the affected cortex is not necessary because the high pressure in the cranium makes a good level of an excavation. We have used a transplant of fat only once.

Then we put pieces of the dura mater in place and join them with fine sutures. Then the bone is replaced and the skin sewed closely.

Surrounding hæmostatic sutures (Heidenhain), we take away on the fourth to fifth day after operation. The other skin suture on seventh day.

As a rule in all our cases we have made operation in one stage except in a case in which we wounded the longitudinal sinus; here we made the operation in two stages.

We have operated in cases of Kojevnickov's epilepsy in seven cases by this described method. All these patients were referred by L. I. Omorokov and R. N. Favodovskii, to whom I express my thanks. The pathological microscopical materials after operations were examined in the laboratory of the Clinic of Nerve Diseases of Prof. L. I. Omorokov.

The removal of the cortical centres in epilepsia Kojevnickov appears by itself, an operation not very objectionable on account of its results. With this operation we try to cure a patient suffering from convulsions, but paralysis of some parts of the body is left after the operation. The question is what is better for him, continual convulsions or paralysis? It seems to us that this question should not have two answers. Continual convulsions with epileptic attacks entails great suffering and so exhausts a patient that a paralysis of one of the limbs appears to be much better. A patient suffering with epilepsy does not only lose a limb writhing in convulsion, but a healthy one with which he tries to keep in quiet the ill limb.

After removal of cortical centres we usually do not find full paralysis. After some time the limbs regain some movement. The flexors begin to work sooner than the extensors. Big joints begin to work before the small ones. The extent of the movement at first is very slight; diversion of the later ones are limited. Mimic of the face and more fine movement of fingers usually are not restored.

The question is why the paralysis begins to lessen. Two suppositions are probable: first, there is some cortical substance left, or neighboring parts of cortical substance compensate the work of destroyed centres. The latter supposition seems to us more probable than the first one, for at the present time it is said that there is no strictly limited localization for centres and that adjoining parts can compensate the action of near-lying centres.

In the most of cases during the operation we found high pressure in the cranium and absence of pulsation, sometimes pushing out of the brain from the trepanning aperture. From this point of view trepanning can serve as a means of regulating intracranial pressure.

The vessels of the cerebral tissues in our cases were usually dilated; in some cases there were commissures between the dura mater and the arachnoid, showing an inflammatory process—meningo-encephalitis—which latter was confirmed by microscopical researches.

Recovery after removal of cortical centres by Omorokov is in 41.66 per cent.

To appreciate final results is an impossible thing because the patients are not investigated closely enough. The low culture of Siberian inhabitants and the great distances make impossible the obtaining of information of their health.

Out of eight cases, in three we had good results. The total epileptic attacks and the local convulsions disappeared, but sometimes, although not often, we could observe slight tremor of separate groups of muscles, so we do not say that they recovered from their illness totally. To a second

TABLE

No.	Age, sex	Preceding illnesses	Length of illness	Hereditary	Localization of convulsions	Frequency and strength of epileptic convulsions	State of muscles of affected organ	Method of operation	State of tunica cerebri
1.	M. 25	Malaria, railway catastrophe	2 years	Sane	Left hand and a little on left leg	Once a month	Considerable atrophy	Removal of centres in one stage	Hyperæmia of arachnoidea
2.	M. 22	No	1 year	Sane	Left hand	Attack in no fixed time	Great atrophy	In two stages. Opening dura mater	Great tension, n pulsation, hy peræmia
3.	F. 11	Typhus, angina, cold	1 year	Sane	Right hand, face or tongue	Seldom	Atrophy of middle degree	In one stage	Without any changes
4.	M. 19	Typhus	8 months	Alkoholismus	Hand and foot	Frequent	Great atrophy	Same	Great tension hyperæmia
5.	M. 27	Wounded many times, alkoholismus	1 year 2 months	Sane	Hand	Seldom	Same	Same	Synechia of dura mater with arachnoidea
6.	F. 20	Childbed eclampsy R Wassermann +	2 years	Epilepsia	Hand, regio humeri, face mus. centre costalis diaphragm, sometimes foot	Frequent 2 or 3 times a month	Considerable atrophy	Same	Walls of vessel become thicke some stripes or them
7.	M. 16	Typhus, pneumonia	2 years	Alkoholismus	Leg	Frequent once in 2 days	Same	Same	Dilatation o vessels o tunicæ
8.	M. 20	Typhus	2½ years	Same	Hand	Frequent	Same	Same	Dura mater be comes thicker hyperæmia

TABLE I.

e of tunica cerebri	Pulsation of brain	Changes in cortex	Electric reaction	Size of removed piece of cortex	Complication at the operation	Period post-operation	Length of observation	Result
ræmia of hnoidea	Absence	Meningo-encephal-itis	Strong	1 c.cm.	No	Smooth	4½ years	Improvement. Not very big convulsions in hand once in 2 weeks. Total epileptic attack after 3 years post-operation.
tension, no ation, hy-emia	Cannot be marked	Cystocercus	Clear	2 c.cm.	Hemorrhage from longitudinal sinus	mooth	1 year	Good.
out any ges	Is marked	Meningo-encephal-itis	Clear	2 c.c.	No	Same	35 days	Improvement.
tension eræmia	Brain is pushed out of aperture	Same	Strong	2 cc.	Hemorrhage from longitudinal sinus	Same	45 days	Not very great improvement.
hia of dura ter with hnoidea	Feeble	Same	Very strong	1½ c.c.	No	Effluxion of liquor cerebro-spinalis	3 months	There were no total epileptic attacks. Local appeared sometimes.
of vessels me thicker e stripes on n	Pulsation weak. Brain is pushed out of aperture	Same	Very strong	3 c.c.	No	Same	1 month	No better.
tation of ssels of cæ	Weak pulsation	Same	Strong	2 c.c.	No	Smooth	1½ months	Good.
mater be-es thicker, eræmia	Cannot be marked	Same	Clear	2½ c.c.	Hemorrhage from longitudinal si-nus	Smooth	1 month and 7 days	Good.

group we refer two cases where we obtained considerable improvement. The total epileptic attacks disappeared, the local convulsions did not disturb the patient as much as before, but yet they did not disappear entirely. The patients could do any work after the operations.

In two cases we did not obtain much improvement. The total attacks became feebler, but the local convulsions were unchanged. And in one case we had not any improvement at all.

It is necessary to give attention to the extent of the process. Good result we have in those cases where the process is limited. In one of our cases the convulsions were only in one hand, in another in foot only. (See No. 2 and 7.)

The result is worse when many centres are touched: lower and upper limbs, hand or arm, and face. (Nos. 3 and 4.)

No effect was obtained in case No. 6, where all the motor centres were affected. Here, in spite of wide removal of cortical centres (3 c.cm.) it was impossible to obtain a good result. In such cases, it may be better to make only a decompression operation.

CONCLUSIONS

In conclusion of all above said, we may say:

(1) It is necessary to remove motor cortical centres in epilepsia Kojevnickov.

(2) Results after operation in many cases depend upon the extent of the process; if the convulsions affect many muscles, the result is worse.

(3) It is necessary to remove cortical centres in a whole piece. The better results therefore are to be had after cutting with scalpel, but not after scraping with a curette.

(4) It is better to make an operation in one stage; the operation of trepanning could not be considered as a difficult one, if one possesses good technic.

(5) To separate an operation into two stages may be recommended in the presence of complications, such as hemorrhage.

(6) The results of our cases we cannot consider to be cleared up, for most of them have not been traced long enough.

(7) The final impression is that we get undoubtedly by operations some relief for total and local convulsions.

PERIARTERIAL SYMPATHECTOMY*

By Ira Cohen, M.D.

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In 1913, Leriche [1] advocated the use of an operation first described by Jaboulay in 1899, and which is now known as periarterial sympathectomy. This procedure consists in the removal of the adventitia of an artery over a varying length, which is followed by immediate changes in the operated limb, contraction of the exposed vessel, subjective and objective coldness of the extremity and diminution of the peripheral pulse. These changes last several hours and are followed by signs of dilatation of the peripheral vessels with subjective and objective increase in temperature and elevation of the arterial pulse pressure. These latter phenomena last five to six days or even longer. Leriche recommended this operation in the extremities for the relief of pain due to vascular causes and claimed that the ulcerations of vascular or trophic origin were benefited. He assigned as a reason for the beneficial results the interruption of the sympathetic innervation of the vascular system distal to the site of operation.

Leriche's observations of the vascular changes locally and distally, as well as clinical improvement, have been confirmed by numerous observers, but the explanation is not as simple as that advanced by him. From an anatomical standpoint Potts [2] demonstrated that the nerve supply to the main arteries of the leg is derived from nerves given off to them at various levels along their course, and the smaller radicles are innervated from sympathetic plexuses on the walls of neighboring parent vessels. Kramer [3] showed a similar arrangement to exist in the arteries of the arm. From a physiological standpoint Langley,[4] in the course of some other work, showed that the usual blanching of the pad in the cat's foot obtained on stimulation of the lumbar sympathetic trunk, gradually grew less and finally ceased when one after another of the peripheral nerves of the leg were divided. Thus from the anatomical and from the physiological viewpoint we are forced to conclude that the nerve supply of a peripheral vessel is not directly interfered with by an operative procedure on a parent trunk. I say directly, for obviously it is influenced in some manner. The immediate peripheral blanching and the fall in temperature, though not likely, might possibly be accounted for by the local contraction in the operative field, but the marked and persistent vasodilatation which succeeds the primary contraction has not been satisfactorily explained. Thus it will be seen that the procedure is entirely an empiric one.

This paper deals with a report of periarterial sympathectomy performed in eleven cases—a series too small from which to draw any final conclusions, but large enough to be of help in evaluating the procedure.

*From the service of Dr. Charles A. Elsberg, at Mount Sinai Hospital, and the author's service at the Montefiore Hospital.

The technic of the operation performed by me does not differ in its essentials from that described by various other authors. The operation may readily be performed under local anæsthesia. For the femoral artery the site chosen is Scarpa's triangle just below the division of the common into the superficial and the deep femoral arteries. After opening the sheath of the femoral vessels the superficial femoral artery is isolated, exposed and slightly raised from its bed for a distance of five to eight centimetres. An incision with a fine scalpel is made through the adventitia along the exposed vessel. The edge of the cut adventitia is picked up with fine forceps and freed by blunt dissection with a thyroid separator or small cranial elevator. When it has been freed for about a half a centimetre along one side, the adventitia may be grasped with mosquito hæmostats placed at intervals. Gentle traction on these clamps while using the separator will cause the vessel to rotate while the adventitia is thus peeled off until the thin fibrous coat is entirely free from the vessel and may be cut away with scissors above and below. In a few places the adventitia may be found more adherent and it may be necessary to free it by cuts with a fine scissors. After removal of the adventitia the vessel presents a smooth glistening appearance, it is then allowed to drop back into its bed and the soft parts are sutured. In the first few cases operated upon I was not certain that the adventitia had been removed, but the presence of nerve fibres was demonstrated by microscopic examination.

In thromboangiitis a periarteritis exists and the adventitia is very adherent so that, not only is the vessel more difficult to isolate, but in the removal of the adventitia, there is a real danger of injury to the vessel wall.† In the senile arteriosclerotic cases there may be seen after the removal of the adventitia calcareous plaques shining through the media, these vary up to a pinhead in size, or even larger, and occasionally the adventitia is adherent over some of these deposits. In thromboangiitis I have not seen the local contraction of the vessel noted in other cases during and after the stripping of the adventitia.

SUMMARY OF CASES

Case I.—Male, aged sixty-one, in Montefiore Hospital because of pain in the left leg and foot with ulcerations of the leg for thirteen months. He had spent ten months in bed prior to admission. The appearance of the ulcerations is illustrated by the photograph (Fig. 1); his knee was held in flexion by muscular spasm. Neither dorsalis pedis nor posterior tibial pulsation was felt in either extremity. Various therapeutic measures were tried to heal the ulcerations and relieve the pain, but without result. On November 21, 1923, under local anæsthesia, three centimetres of the adventitia of the left superficial femoral artery was removed. The gross appearance of the vessel was normal, and after the stripping, it contracted sharply. Immediately after the operation the left foot was colder than the right; six hours later there was complete relief from pain, the leg was extended at the knee, and both subjectively and objectively the left foot was warmer than the right. Three days later the temperature of both feet seemed the same, but there was no return of pain. At the end of two weeks all the ulcers had entirely healed. Three weeks after the operation the patient developed pneumonia from which he died a week later.

† This happened in one case in the series, fortunately without any untoward result.

This was one of the first cases and one with the most striking result. The patient did not live long enough to determine whether the benefit was lasting, but it was the first time in over a year that he had been free from pain and ulcers.

Case II.—Male, aged seventy, admitted to the Montefiore Hospital because of pain in both lower extremities of sixteen months' duration. No pulsation was felt in the arteries of either foot and there was impending gangrene of four toes of the right. On December 17, 1923, under local anæsthesia, four centimetres of the adventitia of the right superficial femoral artery were removed, the vessel appeared normal but did not contract. There was no improvement following the operation and a week later the leg was amputated.

Case III.—Male, aged sixty, admitted to Mt. Sinai Hospital with a six months' history of pain in both lower extremities. On examination no pulsation was felt below

Fig. 1.—Case I. Showing contracture at the knee and the extent of the ulcerations.

the femoral on either side, the left heel had an ulceration and there was impending gangrene of two toes. On October 3, 1924, five centimetres of the adventitia of the left superficial femoral artery were removed. There was no improvement and amputation was done eighteen days later.

Case IV.—Male, aged fifty-seven, a private patient, referred because of pain in the right foot and calf for seven weeks. He had moderate arteriosclerosis of all palpable vessels, but he had pulsation in the peripheral arteries of the foot. There was an early dry gangrene of two of the toes. On January 28, 1924, five centimetres of the adventitia of the right superficial femoral were removed. The artery appeared normal in size and contracted during the manipulations. Shining through the vessel wall, after the removal of the adventitia, could be seen many calcareous plaques. Following the operation there was relief of pain which has lasted one and a half years, except for occasional slight discomfort. Several of the toes were subsequently amputated because of the dry gangrene.

Case V.—Male, aged sixty-five, admitted to the Montefiore Hospital because of pain in the right foot which had been present for six months. On examination no pulsation could be felt below the common femoral artery. On September 18, 1924, five centimetres of the adventitia were removed from the right superficial femoral. At the operation it was noted that the artery was adherent to the vein, that the adventitia was densely adherent and that no pulsation could be seen or felt in the artery. There was no relief following the operation.

Case VI.—Male, thirty-one years old, was admitted to Mt. Sinai Hospital, because of pain in the left leg and foot for two years with ulceration of the big toe for several months. A pre-operative diagnosis of thromboangiitis was made. On May 13, 1924,

five centimetres of the left superficial femoral artery were denuded of adventitia. There was considerable periarteritis and the lumen of the vessel was entered, requiring a lateral ligature. The vessel did not contract after the stripping. There was no post-operative change in the appearance of the foot, but on his discharge fourteen days later he had less pain than on admission. However, the pain returned in seven weeks and he was readmitted, at which time a lumbar sympathectomy was performed by Dr. Harold Neuhof. Following this operation there was a well-marked vasodilatation of the peripheral vessels with increase in warmth of the foot on the operated side and a temporary relief from pain. However, with a return of the pain an amputation was done three weeks later.

CASE VII.—Male, aged forty-four, who had an amputation of his right leg nine months previously, was admitted to the Montefiore Hospital for a painful ulcer in the middle third of the left leg. This ulceration had existed for two and a half years, during which time it had healed and broken down several times. The diagnosis was thromboangiitis. Under local applications the ulcer healed but broke down again after a few days. On January 26, 1924, the adventitia was removed from the left superficial femoral artery. There was post-operative warmth in the foot but no influence on the ulcer. Several months later this healed under local treatment and has remained healed to date. The operation can receive no credit for this result.

CASE III.—Male, aged thirty-nine, a mild diabetic in the wards of the Montefiore Hospital, was seen in consultation because of an ulceration in the middle third of the right leg. The lesion was five centimetres in diameter and very painful. Over a period of several months it resisted all attempts at healing it. Skin grafting was tried several times without avail; the patient was given anti-luetic treatment in spite of all negative tests. On September 6, 1923, a periarterial sympathectomy was done. The vessel appeared normal and contracted, there was post-operative warmth in the foot and for a time a diminution of the pain but no influence on the ulcer. Finally because of pain the leg was amputated at the request of the patient.

CASE IX.—A twenty-six-year-old man had sustained a fracture of the third and fourth lumbar vertebræ seven years prior to his admission to the Montefiore Hospital. At the time of this injury he had been operated upon at Bellevue Hospital by Dr. Harold Neuhof with considerable improvement in his condition. He came to the Montefiore Hospital because of trophic ulcerations of the right heel and buttock. Hoping to benefit the lesion on the heel, on December 13, 1923, a periarterial sympathectomy was done on the right femoral artery. Immediately after the operation the dorsalis pedis and the posterior tibial arteries which had always been readily palpable could not be felt. This was followed by the usual dilatation and warmth. Comparative blood-pressure determinations showed that whereas prior to the operation the pressure was the same in the two legs, 128 systolic, for the first two post-operative days the pressure on the operated side was 134 to 136 as compared to 128 to 130 on the other side. Readings taken after this time failed to show any difference between the two legs. At first no change was noted in the ulcer of the heel, at the end of three weeks there was a questionable improvement, but a week later the ulcer was distinctly smaller and cleaner. However, it never completely healed and remains to date about the same as it was three weeks after the operation.

CASE X.—A man, sixty-four years old, had had the large toe of his left foot amputated because of gangrene in July, 1924. He was admitted to the Montefiore Hospital in November, 1924, because of severe pain in the left leg and foot and an unhealed area at the operated site. This latter healed but the pain persisted. On February 11, 1925, Dr. J. Gottesman did a periarterial sympathectomy on the left superficial femoral artery. At the operation it was noted that no pulsation could be seen or felt in the exposed vessel (none had been previously felt in the branches in the foot). There was no contraction of the vessel observed after the removal of the adventitia. To our surprise

after the operation there was relief of pain, which except for an occasional twinge has persisted.

Case XI.—A woman of fifty-five came to the Montefiore Hospital in May, 1925, because of severe pain in the right leg and foot for fourteen weeks and a beginning moist gangrene of the toes for five days. Following a periarterial sympathectomy done on May 6, her pain was relieved for forty-eight hours, but with the progression of the gangrene it returned and her leg was amputated on May 12.

Of this total of eleven cases seven were of arteriosclerotic origin, two were thromboangiitic, one was a trophic ulcer, and one was an ulcer in a mild diabetic perhaps on a thromboangiitic basis. Three patients were completely relieved of pain, one of whom, however, lived too short a time to determine the permanency of the relief and one subsequently lost several toes in which dry gangrene existed at the time of the sympathectomy. One of the thromboangiitic cases was slightly but only temporarily improved. The trophic ulcer was somewhat benefited. In the remaining six cases no benefit could be seen from the operation. However, I have seen no instance where the operation did any harm.

From this small group of cases I have been unable to determine any method of selecting favorable cases. Success and failure were met in seemingly similar cases. In Case X, where the femoral artery seemed completely occluded at the time of operation, the pain was relieved, although this result was unexpected when the condition of the vessel was noted. One observation was made which may prove of value in the selection of cases when pain is the indication, that is the pre-operative use of an antispasmodic such as benzyl benzoate. Temporary relief was obtained by its use in Cases I, IV and XI (it was not tried in Case X), and in these patients relief of pain was obtained by the sympathectomy. In other cases the drug failed to relieve the pain and so did the operation. Further experience must be had to determine whether this is simply an impression or of actual value in the selection of cases.

It is possible that in some cases of vascular disease of the extremities in addition to the structural changes in the arteries, or perhaps dependent on them, there is a spasm of the finer radicles and capillaries. Where such is the case we may expect beneficial results from a removal of the adventitia. Lehrmann [5] and Läwen [6] believe that the operation of periarterial sympathectomy divides the sensory nerves to the vessel, and by so doing influences the vascular tonus by interruption of the reflex arc. This theory to me seems best to explain the results obtained in keeping with the anatomy and the physiology of the vaso-motor system. The operation would be comparable to the division of the posterior spinal nerve roots for spastic conditions of the skeletal muscles.

CONCLUSIONS

1. In periarterial sympathectomy we have an operation which in some cases causes definite changes in the peripheral circulation.

2. At the present time the explanation of its action is not clear, and the indications for its use are not sharply defined.

3. In my hands the best results have been obtained in patients with pain, due to arteriosclerotic disease of the vessels of the legs.

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NEOPLASMS OF THE BLOOD-LYMPH-VASCULAR SYSTEM WITH SPECIAL REFERENCE TO ENDOTHELIOMAS*

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The observation that tumors diagnosed hæmangiomas not infrequently recur after excision, and in some cases even metastasize until they kill the patient, together with the fact that benign hæmangiomas and so-called malignant endotheliomas often show morphologically indistinguishable areas, usually in the nature of partially differentiated blood-vessels, prompts the following generalizations.

1. Hæmangiomas and lymph-vascular angiomas, although usually benign, are potentially malignant endotheliomas.

2. There is an intermediate stage between the strictly benign and the actually malignant angiomas, represented by hæmangio-endotheliomas.

3. Malignant endotheliomas of the blood-lymph-vascular system exist as a pathologic entity.

My object in this paper is to present the data in support of these generalizations.

Endotheliomas will naturally demand considerable attention in the consideration of a group of tumors arising from an organ in which endothelium plays such a large part, as in the lining of the channels and spaces of the vascular and lymphatic systems. That such tumors arise from the blood-lymph-vascular system is in many instances evident from their study under the low power lens of the microscope, since certain areas are composed of tumor blood-vessels and vessels lined with endothelium.

I shall endeavor to show that there is a solid type of tumor in this group, relatively malignant, which can be seen to develop from, and to be composed of, blood-vascular tissue, which differentiates into endothelial lined channels and blood-vessels, indicating that the function of the adult cells is to line blood channels and lymph channels, and thereby show that the type cell is endothelium and the tumor is endothelioma.

Embryology.—It formerly was taught that endothelium was mesodermal in origin. However, it must be borne in mind that the mesoderm has its anlage in the primitive embryonic ectoderm during the early stages of development, extending laterally from the primitive streak and groove between ectoderm and endoderm. It is therefore logical to suppose that when endothelial tissue becomes malignant, it may in its reversion to embryonic type show morphologic characteristics of both epithelial tissue (carcinoma) and meso-

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dermal tissue (sarcoma). This possible bimorphism of endothelial cells might account for some confusion concerning malignant tumors of the pleura and pericardium. Reports of primary endothelioma and carcinoma of the pleura are common. Robertson,[33] in a recent review of the literature, while reporting four tumors of the pleura and one of the pericardium, has done much to clarify this subject, and in fact shows that endotheliomas or carcinomas of the pleura or pericardium are not primary. He demonstrates that such tumors are secondary carcinomas, usually from the lung, and that if a tumor is primary in the pleura, it must be sarcomatous. The term true endothelium is applied to that derived from the solid mesenchymal part of the mesoblast, in contra-distinction to the celomic or body cavity derivative of the mesoblast which gives rise to the endothelium of the pleura, pericardium, and peritoneum, and is really a mesothelium. The so-called endothelium of the cerebrospinal meninges will not be considered. Mallory [25] points out that it is not genetically identical with the endothelium, lining vascular and lymphatic channels, since it forms at a later period in embryonic development from the notochord.

It seems reasonable to believe that endothelium has in its very earliest development a contribution from both ectoderm and mesoderm, and there are but two important theories of origin of blood-lymph-vascular endothelium, the angioblast theory of His, and the theory of local origin. In the theory of His it is asserted that the so-called angioblast appearing early on the yolk sac gives rise to the endothelium of its blood-vessels which by their proliferation and down-growth invade and form the intra-embryonic vascular systems, also that all intra-embryonic endothelium of whatever nature arises from this preëxisting angioblastic endothelium of the yolk sac, or that there is never a local origin from mesenchymal tissue. In the theory of local origin, described by Reagan,[30] it is asserted that mesenchyme may, in practically any part of the body, change into blood-lymph-vascular tissue, and is not necessarily in direct descent from the yolk-sac endothelium of the angioblast. The theory further presumes that mesenchymal cells can by migration and alignment form vascular channels or cavities lined by endothelium, and that there are various embryonic regions where there is a first-hand production of vascular tissue, even to blood-cells themselves.

The "theory of local origin" is probably the most favored explanation of the origin of the vascular and lymphatic systems among competent anatomists and embryologists to-day. Sabin [35] supported the angioblastic theory of intra-embryonic lymphatic development. By injecting India ink into subcutaneous tissues of pig embryos, she showed to the satisfaction of many that all lymph-vessels budded off from the veins at four primary centres, and then invaded the skin, as well as the deeper tissues, by a process of centrifugal growth. Clark, Evans, and Minot also supported this view, and in fact, by 1912, this theory seemed generally accepted.

The theory of the development of endothelium *in loco* from mesenchyme dates from the work of Reichert, Goette, Felix, and more recently Rüchert

and Mollier, Maximow, Bonnet, and other European anatomists. Huntington and McClure until recently were its only sponsors in this country. Their series of convincing articles is summed up in Huntington's monograph which appeared in May, 1911. In 1912, Kampmeier demonstrated independent lymphatic endothelium anlagen in the thoracic duct of an injected pig embryo. Emmel, Reagan and Stockard stand as proponents of the theory of the local origin of endothelium. Soon even Sabin was led to accept in part the local origin theory by her studies of intra-embryonic blood-vessels and the formation of red blood-cells in living embryo chicks.

From now on the pendulum swings toward the theory of local origin, and McClure gives the present predominant opinion in the following words:

"While differences of opinion may still exist, as regards details of the process, both for the lymphatic and blood vascular systems, it is plain from this brief sketch that the general principle of the local genesis of intra-embryonic endothelium from mesenchyme, a theory so recently and so vigorously opposed by a large group of American anatomists, may now be regarded as an established fact." This statement has an important bearing on tumors of endothelium.

Problems of Classification.—Most tumors of blood-vessels and lymph-spaces have been easily recognized and correctly described and diagnosed as capillary or cavernous lymph-angiomas and hæmangiomas. When the cellular activity of these tumors becomes such that open spaces give place to solid masses and the compact areas are composed of endothelium-like tissue rather than fibrous tissue or epithelial cells, the classification and correct diagnosis become controversial. Invasion of adjacent tissues, local post-operative recurrence and metastasis further complicate the picture.

MacCallum says, "In practically no case has the origin of a tumor from endothelium been proved." But theoretically tumors of endothelium can occur in any part of the body, since that kind of tissue exists in or about all organs.

Most pathologists classify malignant tumors from the standpoint of the predominating cell, considering not only its structure, but also its embryonic origin, for when very malignant it loses all likeness to its adult functioning form.

Mallory [20] says, "The type cell is the one important element in every tumor." He goes on to show that histologic classification of slow-growing tumors is satisfactory, for they differentiate well, while with fast-growing ones embryology helps in recognizing types of cells and in explaining unusual situations of tumors. Ewing summarizes the problems of the classification of tumors as follows: "The generally accepted plan of classification and terminology which is based on histology, modified as much as possible by histogenesis, is a natural product which has become very firmly established and probably deserves to prevail against the varying prominence of embryology, chemistry, and etiology." A purely embryologic classification is not sufficient, as the origin of some parts of the body is not well understood. For instance, the Wolffian body may not be really mesoblastic; and again the adenomas,

and even so-called carcinoma of the kidney, instead of being classified as mesotheliomas, as they should if these organs are derived from mesothelium, are called epitheliomas. A strictly embryologic classification falls short in tumors such as malignant endotheliomas, which at times cannot be distinguished from carcinomas, or indeed, sarcomas by their histopathologic structure. Structure alone is insufficient as a criterion for classification of many tumors, for, as previously stated, highly malignant tumors, even from most dissimilar tissues, are indistinguishable.

A third great help in the classification of neoplasms, seldom mentioned in the past, is the knowledge and study of "reserve cells." The embryologic conception of three germ layers, as applied to tumors, while convenient in classifying neoplasms, is no longer necessary, and is in fact a mental hazard which keeps the more enlightened present-day conception of tumors from being accepted in practice. As MacCarty has shown in cancer of the breast that the membrana propria or "reserve cell" is the key to early carcinoma, so an attempt must be made to discover the embryologic "reserve cell" in studying tumors supposed to have arisen from vascular or lymphatic channels.

Endothelium.—Endothelium is spoken of as a primitive tissue, growing by "sprouting" as well as by mitotic division.[5] It is known that it comes from preëxisting endothelium. McClure [23] and others have demonstrated the mesenchyme cell to be the reserve cell of endothelium in the embryo.

It is usually stated that the specialization concomitant to the demand for function in adult organisms destroys the power of regeneration directly in proportion to the degree of specialization. In the adult, reproduction in such a tissue as endothelium is supposedly by direct division or sprouting, and occasionally by mitotic division, mesenchyme cells no longer being visible. This failure to find a "reserve cell" for endothelium in the adult has its exceptions. MacCallum describes connective tissue that has assumed the structure and function of endothelium in the repair of an infected wound of the neck of the adult dog. He explains this as a "kind of metaplasia, analogous to that which occurs in the first formation of endothelium." I have seen this same process in tumors of endothelial-lined spaces with adjacent areas showing solid masses of cells morphologically indistinguishable from endothelial cells. Considering these different cells as derived from mesenchyme, it is no wonder that they sometimes show in the adult a multiplicity of form, approaching in appearance, fibroblasts or fibrocytes here, epithelioblasts there, and again endotheliocytes in other places. This may be a manifestation of metaplasia, but might better be called an example of atavism since it is an inheritance from remote rather than immediate ancestors, from mesenchyme rather than fibroblasts.

If there is sufficient injury to destroy adult tissue of so-called mesoblastic origin, the mesenchymal primitive connective tissue responds to the demand for repair. This cell usually looks like a fibroblast, but may, and in fact ought, at times to resemble, in different environments and in different stages

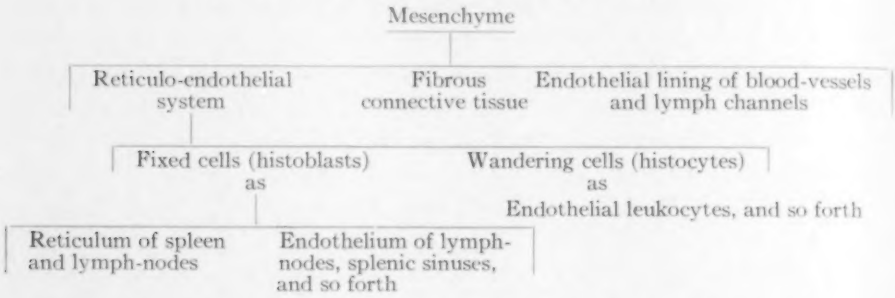
of repair, other different types of specific cells or tissues that arise from it, such as the following:

1. All the cells of the reticulo-endothelial system such as the reticular cells of splenic stroma and lymphatic tissue as well as the endothelial cells of the liver, lymph-gland and spleen sinuses, adrenal and hypophyseal capillaries (histoblast), fixed tissue cells, and the histocytes and wandering tissue cells such as the endothelial leukocyte series of cells.[1]

2. The connective-tissue series of cells which in adult form are called fibrocytes.

3. The endothelial cells lining blood-vessels and lymph-channels.

CELLS DERIVED FROM MESENCHYME


Mesenchyme
Reticulo-endothelial system
Fibrous connective tissue
Endothelial lining of blood-vessels and lymph channels
Fixed cells (histoblasts) as
Wandering cells (histocytes) as
Endothelial leukocytes, and so forth
Reticulum of spleen and lymph-nodes
Endothelium of lymph-nodes, splenic sinuses, and so forth

It is evident, therefore, that a certain polymorphism will be seen in tumor cells derived from the endothelial lining cells of the blood-lymph-vascular system, one of these so closely allied series of cells, so alike in function and origin. These tumors are therefore divided into three distinct groups, considering all endothelium-lined vessels as one, whether they contain blood or lymph: (1) angiomas, (2) angio-endotheliomas, and (3) endotheliomas.

The name endothelioma does not indicate its derivation from blood-channels or lymph-channels. The reasons for including it are brought out in the discussion. Suffice it to say that certain areas in the angio-endotheliomas, taken apart from the definitely vascular areas, simulate exactly morphologically the small group of tumors (Group 3), previously called endotheliomas, and seems to place the origin of the latter also in the lymph-blood channels.

Material Studied.—This report, while primarily a histopathologic study, includes a review of the clinical findings and end results of 290 cases of neoplasms at the Mayo Clinic, which were reported to have arisen in the blood-lymph-vascular system during the sixteen years from 1907 to 1922, inclusive. The material is only from the surgical pathologic laboratory and includes specimens removed at operation, but none of the many angiomas found in the internal organs at necropsy. The tissue was studied independently of all diagnoses, reports, or other data. Of the 290 cases on file ninety were discarded for various reasons; many specimens were lost; there was not sufficient material for proper study in other cases, and in some of the earlier ones the diagnoses were incorrect, especially in the endothelioma group.

The following tumors have been called endotheliomas in the past: mixed tumor of the parotid gland and palate, squamous-cell epithelioma, melanotic epithelioma, adamantinoma of the jaw, carcinoma of the appendix, metastatic epithelioma of the chest, neuroma, and benign xanthic tumor of the tendon sheath. Two very interesting tumors of the upper extremity with skin involvement were discarded, as they were probably Ewing's primary endotheliomas of bone. Another tumor, while resembling endothelioma, was thought at necropsy to be possibly of primary osteogenic origin, and was discarded. Follow-up letters were sent to all living patients not heard from within a year.

Tumors arising in celomic endothelium, such as those in the peritoneal cavity, pleura and pericardium, are not considered in this study, nor the so-called endotheliomas of the cerebrospinal meninges. Several tumors of the orbit were ruled out as probably of this origin.

On microscopic examination, the different specimens, with the exception of one type, arrange themselves into certain groups which conform very well to the classification already offered for such tumors. The one exceptional type of neoplasm is what has been variously named endothelioma, angiosarcoma, perithelioma, cylindroma, and so forth, fibrosarcoma, mixed-cell sarcoma, or not infrequently, carcinoma.

The neoplasms studied comprise three large groups: (1) angiomas, (2) angio-endotheliomas, and (3) endotheliomas. The term angioma is used to include tumors of both blood-vessels and lymph-vessels. For convenience of arrangement they are divided into ten main groups, according to their anatomic location (Table I).

TABLE I

Two Hundred Cases of Neoplasms of the Blood-lymph-vascular System, Showing Frequency of Occurrence of the Angioma, Angio-endothelioma and Endothelioma.

Location	Cases	Per cent. of total	Angioma		Angio-endothelioma		Endothelioma	
			Cases	Per cent.	Cases	Per cent.	Cases	Per cent.
Breast	7	3.5	6	85.7	1	14.3		
Extremities (upper)	28	14.0	22	78.5	5	17.9	1	3.6
Extremities (lower)	28	14.0	25	89.2	1	3.6	2	7.2
Gastro-intestinal tract	7	3.5	7	100.0				
Genito-urinary tract	20	10.0	19	94.7			1	5.3
Head and face	36	18.0	33	91.7			3	8.3
Lip	34	17.0	34	100.0				
Neck	11	5.5	11	100.0				
Tongue	16	8.0	16	100.0				
Trunk	13	6.5	10	76.9	2	15.4	1	7.7
Total	200	100.0	183	91.5	9	4.5	8	4.0

DESCRIPTION, TREATMENT AND RESULTS

Angiomas.—Angiomas are obviously benign, circumscribed tumors, often noticed at birth, occurring almost anywhere on the surface of the body, and occasionally in the internal organs. They cause great trouble only when congenital or in children of tender years, or when very extensive and so

situated that important structures are involved by direct extension of their growth. They are easily recognized grossly in the fresh condition by their reddish color and spongy, fibrous appearance. On section of such tumors, if cavernous in structure, the red color disappears with the outlet of the blood and serum, leaving a pale spider-web or honey-comb, relatively soft, mass of tissue. If they are large and contain blood from old hemorrhages or thrombosed blood cavities, dark red and blackish areas will be present, showing a deposit of laminated blood clot and hæmosiderin and hæmatoidin. Certain of these tumors, occurring in the skin, as so many do, contain true melanin, which does not, however, give a Prussian blue with potassium ferrocyanid solution, as do the iron-containing hæmosiderin crystals found in destroyed blood.

Under the microscope, a varied histologic picture is seen, with, as a rule, either blood spaces or fibrous tissue predominating, the arrangement of which has prompted the application of such descriptive adjectives as capillary, cavernous, villous, plexiform, and so forth. Obviously benign to the trained pathologist, these tumors at times show such cellular activity and so many histologic deviations from type that mistakes are not infrequently made in diagnosis. The absence of blood spaces in some, or the origin from lymph spaces almost totally unrecognizable in the fixed preparations, may lead to a diagnosis of fibroma, neurofibroma, or even sarcoma or endothelioma, when the tumor is growing quite rapidly. On the other hand, a relatively malignant angio-endothelioma may, because of its widespread differentiation into blood spaces and vessels, be called wrongly a benign angioma when it indeed is the immediate precursor of a malignant endothelioma. Other confusing pictures seen in those tumors arising at the body surface are due to reactions in the contiguous skin elements, such as squamous-cell epithelium, sweat glands and hair follicles. Marked hypertrophy of the squamous-cell layer is so frequent that the tumor may occasionally be mistaken for a squamous-cell epithelioma. Basal-cell epithelioma is also simulated by marked hypertrophy of the cells of hair follicles.

Among the rarer variations from the structure usually seen in angiomas may be mentioned phlebolith or psammona formation, foreign-body giant-cells simulating tubercle formation, and so forth (Table II).

The six sites of election for the angioma group, in order of numerical frequency, were: lip, head (including face), lower extremities, upper extremities, genito-urinary apparatus, and tongue. Of 149 (75.4 per cent.) of the total of 183 occurring in these situations, 62.3 per cent. were found in the lip, face and extremities. The average age of the patients when seeking treatment was thirty-five and two-tenths years; the youngest was ten weeks, and the oldest seventy-six years. Thirty-four angiomas (18.6 per cent.) were reported to be congenital. More than half the patients were female, 118 of 183 (63.9 per cent.). Only seventeen (9.3 per cent.) gave a family history of malignancy or "birth marks," and an equal number a history of injury. The average surface diameter of the lesions was 3.3 cm., the largest being

TABLE II

Detailed Clinical Data of the Angiomas

Situation	Patients								Tumors								Treatment				Result of treatment		Associated lesions
	Cases	Per cent. of total	Average age of patients, years	Age of youngest patient, years	Age of oldest patient, years	Males	Females	Family history of malignancy or birth-mark	Injury	Congenital cases	Average pre-operative duration, years	Average size, cm.	Largest size, cm.	Smallest size, cm.	Multiple	With associated neoplasm	Previous	Excision	Excision and radium	Radium	Recurrent	Patients not cured	
Breast	6	3.3	45.5	27.00	45.5		6	1	1		9.0	1.0	1.2	0.30	6	1		6					Basal-cell epithelioma of of chin.
Extremities (lower)	25	13.7	38.8	.58	60.0	6	19	1	1	9	11.1	3.3	7.0	2.00	1	4	2	23	2		4	*3	Three goitres; one adenofibroma of breast. *One toe amputated without cure.
Extremities (upper)	22	12.0	30.6	.20	66.0	4	18	1	3	6	12.4	2.6	18.0	0.50	4	2	8	*18	3	1	4	1	One squamous-cell epithelioma of forearm; one lipoma. *One amputation necessary.
Gastro-intestinal tract	7	3.8	44.6	22.00	67.0	2	5	1			3.0	7.1	15.0	2.00	2	2		7					One squamous-cell epithelioma of lip; one pelvic tumor.
Genito-urinary tract	19	10.4	41.2	19.00	76.0	5	14	2	1		3.8	4.0	10.0	0.50		3		*18		1	3		One uterine fibromyoma; two goitres. *Two excision and fulguration.
Head and face	33	18.0	30.3	.27	60.0	22	11	5	6	6	5.0	3.3	10.0	0.50	3	4	9	25	7	1	1	1	One goitre; one basal-cell epithelioma of cheek; one melano-epithelioma of ankle; one squamous-cell epithelioma of jaw.
Lip	34	18.6	38.1	.65	71.0	18	16	5	3	3	5.7	1.4	3.0	0.50	1	5	10	31	3		3		Two goitres; one lipoma; one squamous-cell epithelioma of lip; one leukoplakia of mouth.
Neck	11	6.0	22.2	.25	65.0	4	7			5	9.6	5.5	10.0	1.0	1		2	9	2		4		
Tongue	16	8.7	36.0	2.5	66.0	9	7	2	1	3	3.7	1.6	3.0	1.0		1	3	13	3		5		One squamous-cell epithelioma of lip.
Trunk	10	5.5	34.3	1.4	76.0	5	5		1	2	7.3	3.6	15.0	1.0		1		10					One uterine fibromyoma.
Total	183					75	108	18	17	34					18	23	34	160	20	3	24	5	
Averages			36.1			41	59.1 per cent.	9.8			7.06	3.34	9.22	.93							13.1 per cent.		

an angioma of the stomach, 15 cm. long, while the smallest was 3 mm. in diameter. Twelve cases were multiple. Thirty-four patients came with a history of previous treatment. The records show that the treatment of choice at the Mayo Clinic was knife excision, which was employed in 160 of the 183 cases. This was followed by applications of radium if the site and extent of the lesion did not permit complete excision. Radium was used alone in only three cases.

Angio-endotheliomas.—Angio-endotheliomas comprise a relatively small percentage of the total cases, but are the most important ones for study, as they appear to be a connecting link between the benign angioma and the malignant endothelioma. There were nine cases: six in the extremities, two in the trunk, and one in the breast.

Angio-endotheliomas do not differ grossly from angiomas, save that they are more irregular in outline and appear, as a rule, more solid in certain areas, and more meaty on section. The microscopic picture differs from that of the more circumscribed benign angiomas in two main respects. The first and most important difference is the presence of an occasional mitotic figure. The change from the benign to the malignant state is best indicated by this landmark. The malignant endotheliomas contain numerous mitotic figures. The second difference is that the cavernous or fibrous areas, characteristic of the angioma, give way in small areas to solid masses of larger, less differentiated cells whose structure, studied under the higher-powered lenses of the microscope, is seen to approach that of endothelial cells. These cells, however, continue to grow into numerous vessel-like channels in most areas, still suggesting that a capillary type of angioma is present. The reaction in surounding tissue is somewhat different, but the diagnosis should be based entirely on cytologic study. The differentiation into vessels, which in this case are tumor vessels, is analogous to the formation of keratin pearls in a relatively benign, although definitely malignant, squamous-cell epithelioma.

The repeated recurrence of angio-endotheliomas after apparently adequate excision prompted more careful study of them, until now a definite group can be recognized. These tumors are considered cytologically the forerunners of a definitely malignant tumor of endothelium. In order to indicate their pre-malignant or early transition stage, I have called them angio-endotheliomas. They are relatively benign, malignant tumors, their growth being checked by their differentiating into blood-vessels.

Five of the nine angio-endotheliomas appeared on the upper extremities. There was recurrence in four cases, metastasis in one, and two patients died, one of whom was a child of eleven with extensive involvement of the jaw and mouth.

On account of the small number in the series, and the similarity in the numbers of angio-endotheliomas and endotheliomas, groups 2 and 3 will be discussed together and analyzed in one table (Table III).

Endotheliomas.—The endotheliomas comprise a rare group of tumors lying morphologically midway between carcinomas and sarcomas, but are as

TABLE III

Detailed Clinical Data of Angio-endotheliomas and endotheliomas

Situation	Patients									Tumor		Treatment			Results				Remarks
	Number with angio-endothelioma	Number with endothelioma	Percentage of total	Average age, years	Age of youngest, years	Age of oldest, years	Males	Females	Injury	Family history of malignancy	Average pre-operative duration, years	Average size, cm.	Largest, cm.	Smallest, cm.	Previous	Excision	Excision and radium	Recurrence, angio-endothelioma	Recurrence, endothelioma	Metastasis, angio-endothelioma	Metastasis, endothelioma	Dead from angio-endothelioma	Dead from endothelioma	
Breast	1		5.9	38.0	38.0	38.0		1		0	1	5	5	5			1	1		1		1		
Extremities (lower)	1	2	17.6	31.3	24.0	53.0		3		0	6.3		*	2	2		1		2		1		1	*Extensive in foot and leg.
Extremities (upper)	5	1	35.4	32.8	26.0	45.0	3	3	1	0	5.3	2.6	13×8	1	3	4	2	3	1					
Genito-urinary tract		1	5.9	38.0	38.0	38.0		1		0				1	1				1					
Head and face		3	17.6	14.7	11.0	17.0	1	2	1	0	.6	4.5	6	3	3		1	1	1		1			
Trunk	2	1	17.6	51.0	48.0	51.0	2	1	1	0			15	1		2	1		1			*1		*Died from angina pectoris
Total	9	8					6	11	3	0					9	9	6	5	6	1	1	3	1	
Average	52.9 per cent.	47.1 per cent.		34.3	30.8	40.3	35.3 per cent.	64.7 per cent.		0	3.3	4.0	8.6	2.4										

a rule relatively benign, as judged by their long duration and the tardiness and infrequency of metastasis.

There were eight cases of endothelioma, distributed as follows: extremities, three; head, three; and trunk and genito-urinary tract, one each. There was recurrence in six, metastasis in one, and death in one.

The gross appearance of endothelioma arising in the blood-lymph-vascular system in this series was quite similar to that of fibrosarcoma. Hemorrhagic and cystic areas are as a rule strangely lacking, and it is thought probable that this is one of the chief reasons why their origin from blood-lymph-vascular endothelium has been overlooked. The cut surface looks grayish in the fresh specimen, but is quite white and fibrous-appearing when it is fixed in formalin. It is fairly homogeneous, as a rule, without irregular lobulated areas, although fibrous tissue strands are seen.

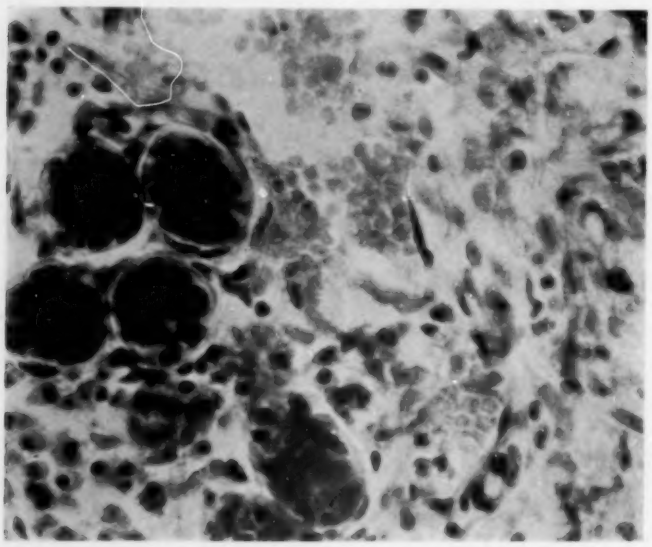


FIG. 1.—Malignant angio-endothelioma of breast showing red blood cells in the angiomatous spaces in the immediate vicinity of the most malignant part of the tumor. An example of differentiation into blood-vessels. (X 500.)

The microscopic section shows that the tumor is quite cellular with numerous mitotic figures and frequent invasion of fat and muscle. Morphologically the cell resembles endothelium, although it is more spheroidal in shape and larger, and the nuclei show hyperchromatosis. Differentiation into tumor blood-vessels is seen in some instances. There may be fairly large areas of fibrotic tissue and lymphocytic infiltration, and even hyalin formation. In some areas the similarity to the histologic picture of a certain stage of Hodgkin's disease is striking. The numerous mitotic figures in masses of rather undifferentiated cells signify malignancy, and the differentiation of certain of the tumor cells into blood-vessels indicates its endothelial type.

Angio-endothelioma and endothelioma are less common than angioma. The average age incidence is earlier, much earlier if the birth nævus is omitted, the predominant sex is female, the average pre-operative duration is shorter, treatment is less successful and recurrence more common (ten out of seventeen compared to twenty-four out of 183 cases). Metastasis and death, while not encountered in cases of angioma, followed both angio-endothelioma and endothelioma.

Very little difference is found between angio-endothelioma and endothelioma. It is important that the former be recognized as more than a simple angioma, so that it may be eradicated before it advances in malignancy and becomes an endothelioma. Important distinguishing clinical features are lacking and differential diagnosis is impossible, so that the burden of diagnosis is placed on the pathologist. His information, while of scientific importance in emphasizing the morphologic and cytologic truths shown by the tissue, should not influence the treatment of the two groups of tumor, for each should have early, wide surgical excision followed by prolonged radium treatment and frequent observation to prevent local recurrence, if possible. If such occurs, immediate further excision is required. Metastasis is rare from these tumors and occurs late.

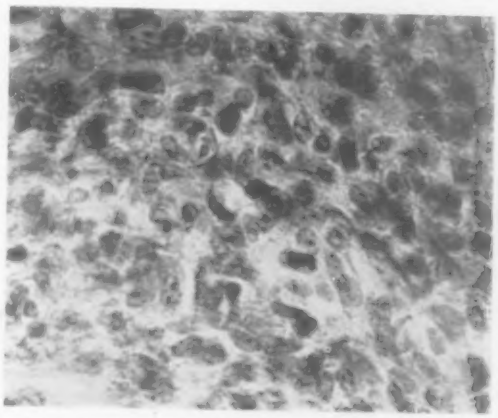


FIG. 2.—Same as Fig. 1, showing rapidly multiplying round and oval malignant cells with multiple examples of mitotic figures. (X 450.)

CASE REPORT I.—A woman, aged thirty-eight years, came to the Clinic May 29, 1921, complaining of tumor of the left breast slowly recurrent in the scar resulting from the simple amputation in 1917 for a "fibro-epithelial" tumor. The family and personal histories gave negative information, and there was no record of tuberculosis or malignant disease in the family.

She was a healthy looking, vigorous young woman with a good color. Nothing abnormal was found except an irregular, soft mass in the scar of the operation on the breast, with several bluish-red areas in the surrounding skin, and fibromyoma of the uterus. The Wassermann reaction was negative; the hæmoglobin was 70 per cent. (Dare); the erythrocytes numbered 4,080,000, and leucocytes 6100. The differential count and platelet count were within the normal bounds, and bleeding time was three minutes. A röntgenogram of the chest was negative.

The patient submitted to nine operations for recurrent tumors from April, 1921, to December 12, 1923, death occurring April 21, 1924, from general asthenia and absorption from growths. April 1, 1921, the tumor in the scar of the old incision was excised. The pathologic report was hæmangioma. Six months later the patient noted a recurrent local tumor, 7 by 7 cm., a lump in the right breast, about 10 cm. in diameter, and a small bluish tumor in the left deltoid region. A bluish nodule was found in the cervix uteri. August 16, 1922, the right breast was amputated and the glands excised. The pathologic report was hæmangio-endothelioma of the breast on an angioma; glands inflammatory. Radium was applied to the recurrent tumors in the left chest, the arm, and the cervix. April 2, 1923, the tumors in the left breast and left arm were excised. The pathologic report was hæmangio-endothelioma. July 11, the patient's general health was good in spite of the recurrence; more radium was applied. October 9, multiple nodules on the left chest and left arm, and one on the left back just above the iliac crest were excised. The pathologic report was again hæmangio-endothelioma (Figs. 1-6). December 12, nodules in the left chest, arm, back, and shoulder (twenty or more) were cauterized between the scars of the previous operations. April 21, 1924, the patient died from asthenia and "absorption."

Comment.—This case illustrates how a benign hæmangioma may become a locally malignant hæmangio-endothelioma, and eventually show the characteristics of malignant endothelioma, ending in metastasis and death.

Discussion.—Wagner,[38] in 1874, described a malignant tumor of the endothelium occurring in the pleura. His description of the tumor cells, apparently primary in the lymph channels, led subsequent observers to record similar cases as primary tumors of the pleura, and Eppinger called such a tumor "endothelioma." Since then various writers have reported and described tumors as of endothelial origin, but attention seems to have been focussed on the endothelium of serous membranes and bone, to the exclusion of the endothelium of the blood-lymph-vascular channels. Dermatologists have, from time to time, reported tumors involving the skin, whose cellular elements present the histologic characteristics of endothelial cells.[4] Kaufmann, as late as 1922, stated that endotheliomas belong histogenetically to the connective-tissue tumors. If my conception of the origin of endothelium is correct, endothelium does belong, histogenetically, to connective tissue. In the case of tumors of the blood-lymph-vascular channels it can apparently be recognized as a special form of connective tissue, and therefore the tumors are classified as endotheliomas. Ewing's well-known primary single or multiple endotheliomas of bone seemed to be established without cavil.

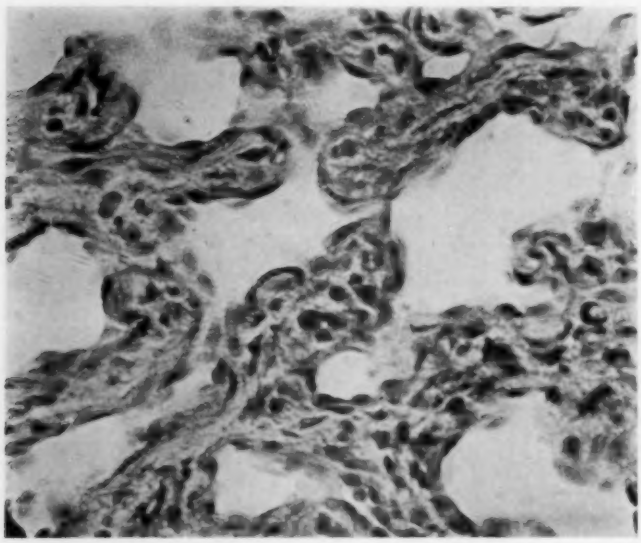


FIG. 3.—Differentiation into endothelium-lined channels and spaces. (X 500.)

It seems that there has been gradually increasing opposition to the conception of endothelioma as a distinct type of neoplasm. While fair so far as the serous membranes (celomic endothelium) are concerned, it would not seem justified by the study of the present series of tumors.

Since cells on becoming malignant lose or fail to acquire the characteristics by which they are known and classified in their completely differentiated state, it is necessary to investigate carefully the origin of the tissue under discussion, if it is not to be confused with other tissue or tumors when it becomes malignant.

Some malignant neoplasms are known to develop from a benign growth. A pigmented mole may become a melanotic epithelioma. Cancer of the

stomach is supposed to develop from simple gastric ulcer.[40] Leukoplakia sometimes becomes squamous-cell epithelioma.[29] Fibromas of the nasopharynx and other tissues show increasing degrees of malignancy, hastened and accelerated by repeated operations. A true conception of advanced growths is often best reached by a careful investigation and study of the earlier stages of their development.

In reviewing the development of a modern conception of growth and repair of tissues and a cytologic interpretation of tumor formation and malignancy, the contributions of Cohnheim, Hansemann, MacCarty and Broders should be considered and contrasted. In 1877, Cohnheim suggested in a lecture to a group of students that his "rest" theory or theory of the formation of *monstra per excessum* superfluous fingers, giant extremities, and so forth, by embryonic cell inclusion, might also apply in the great and wider field of true neoplasms. This hypothesis has been for almost half a century accepted as a fact, although never proved. Many pathologists to-day, however, believe that just as a fertilized ovum is totipotent as regards the cells and tissues of the adult organism which develops from it, so certain early segmentation cells are multipotent, and each cell then is the possessor of inherent potentialities for development into various forms, tissues or organs. This property of the cell would explain the *monstra per excessum* teratoma, mixed tumors, and so forth.

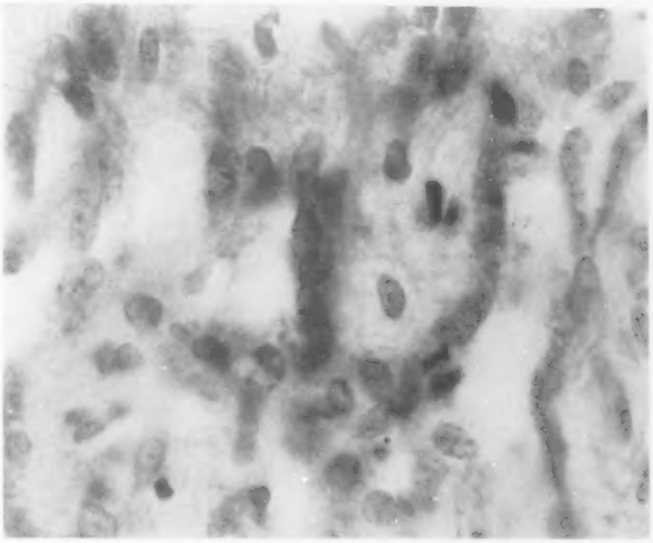


FIG. 4.—Angio-endothelioma showing endothelium-lined channels, malignant as indicated by mitosis. (X 1000.)

MacCarty[22] says the three fundamental biologic reactions in cases of neoplasia are hypertrophy, hyperplasia, and migration of the reserve cell on destruction of its overlying adult cell. He has called these reactions primary, secondary and tertiary cytoplasia. This work shows how nature has provided "reserve cells" in the mammary acinus to replace the destroyed adult cells. I believe endothelium has a reserve cell also. In the embryo it is clearly mesenchyme. In the adult it has not been identified. The terms, primary, secondary, and tertiary cytoplasia, do not represent degrees of malignancy, although they do express the biologic reactions which occur in the histogenesis or development of a malignant tumor.

Hansemann[14] wrote a great deal about the morphologic variation of tumors, but described them in terms of anaplasia and de-differentiation, and not in degrees of malignancy. He was intensely interested in the fact that malignant tumors, such as a carcinoma of the thyroid or of the liver, could, after metastasis to the brain or elsewhere, differentiate enough to perform their adult function as seen by the production of colloid and bile.[15] He quotes a report by von Eiselsberg who removed a carcinoma of the thyroid with resulting myxœdema. When later a metastatic tumor developed to a certain size the myxœdema was relieved only to return on excision of the tumor. It remained, however, for Broders in 1919 to apply this principle of cyto-differentiation, as he saw it in various types and parts of malignant neoplasms, to the grading of malignancy. It is mentioned here, as he shows in another tissue, protective epithelium, how the reserve cell is the key to the situation.

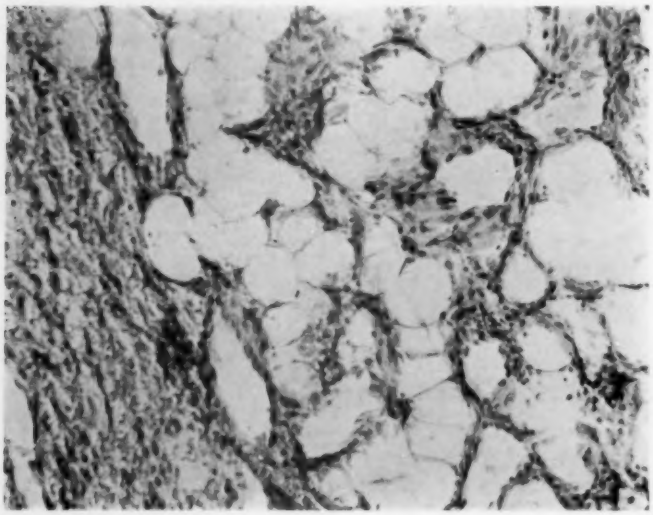


FIG. 5.—Angio-endothelioma showing invasion of fat by malignant process. (X 120.)

On the principle of differentiation by which he grades squamous-cell epitheliomas, it would seem possible to grade endotheliomas by an estimation of the amount of tumor blood-vessel formed. This has not proved of practical clinical value in this series of tumors, possibly because the malignant tumors appeared to be of a uniform degree of malignancy. Theoretically, and from the standpoint of cytology, however, it is possible to divide the malignant members of this group into grades according to the amount of differentiation into blood-vessels and connective tissue, frequency of mitosis, and the general tissue reaction. With the establishment of such a tumor as a malignant neoplasm of endothelium, the next step should be to determine toward what type of cell they differentiate, their degrees of differentiation, and then possibly the grade of malignancy.

The stratum germinativum of the skin as a forerunner of squamous epithelium and the fibroblast as the immediate progenitor of fibrous connective-tissue cells are good examples of reserve cells. Likewise, in the breast, when the secreting acinar cells are destroyed, they are replaced by cells from the so-called basement membrane. Reserve cells of breast acini are not seen in non-lactating, normal adult breasts.

The endothelial cell is very primitive and the usual reaction to injury is seen in replacement by direct division of preëxisting endothelial cells. The endothelial cell is more widely distributed throughout the body than almost any other kind, except perhaps the fibrous connective-tissue cell. It is possible then that the reserve cell of endothelium is identical with that of fibrous connective tissue, namely, the fibroblast, or that the primitive mesenchymal cell seen in the embryo as the forerunner of both is the reserve cell of endothelium, and that the mesenchymal cell lies invisible throughout the supporting structures of the body, ready to spring up into a malignant growth on adequate provocation, if the host has the proper hereditary tendency to tumor.

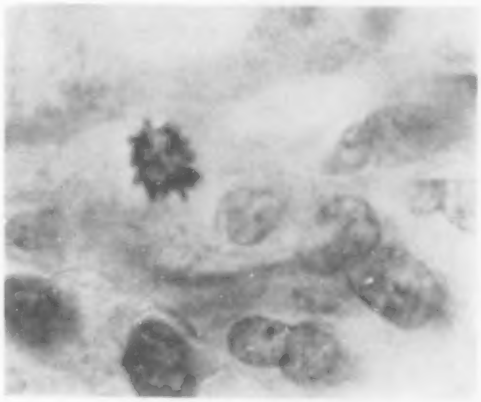


FIG. 6.—Angio-endothelioma superimposed on an angioma of the breast showing the highly malignant character of the growth. Large round and oval cells with irregular mitotic figure. (X 1500.)

If, in the case of the definitely malignant solid tumors of this series, arising from vascular tissue, the cells are too undifferentiated to be called endothelial cells, it is fair to suppose that they are genetically related cells, are surely not epithelial cells, often simulate fibroblasts, and because of their relation to vascular channels are most likely endothelioblasts. Almost invariably in some part of the neoplasm, perhaps in some cases so early in its development that it is not seen, there is definitely differentiated blood-vascular tissue.

SUMMARY

A histologic study of the neoplasms of the blood-lymph-vascular system of 290 patients treated at the Mayo Clinic in the sixteen years from 1907 to 1922, inclusive, shows 183 angiomas, nine angio-endotheliomas, and eight endotheliomas. Two hundred of the best preserved specimens, with full data and follow-up records, were selected for report. This simple classification seems adequate to meet all the clinical facts of the cases as well as all the known data from the standpoint of embryology, morphology, situation, and "reserve cell" diagnosis.

Endothelium in the embryo is derived from mesenchyme. In adult tissues, although not yet identified, the same mesenchymal cell lying invisible seems most likely to be the reserve cell of endothelium. Endothelium is closely linked with fibrous connective tissue in that mesenchyme is their common ancestor. This relationship does not preclude the existence of a specific tumor of endothelium, distinct from a fibrosarcoma.

The study of angiomas led to the recognition of the origin of the malignant tumors of this series from vascular endothelium. A case reported shows the change from benign to malignant in different stages. Specimens were

removed at operation during a period of three years, death finally occurring from metastasis and absorption from the growths.

The original hypotheses seem established as facts: blood-vascular and lymph-vascular angiomas, while usually benign, are potentially malignant endotheliomas; there is an intermediate stage between these two represented by the angio-endothelioma which is relatively benign but definitely malignant; and malignant endotheliomas of the blood-lymph-vascular system exist as a pathologic entity.

Just as a malignant tumor of the skin is recognized as a squamous-cell epithelioma by its differentiation into horny, protective epithelium, so may certain of the blood-lymph-vascular tumors be recognized as endotheliomas by their differentiation into tumor blood-vessels.

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THE KLIPPEL-FEIL SYNDROME

NUMERICAL REDUCTION OF CERVICAL VERTEBRÆ

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Anatomic variations may be found in any part of the spine, but much less frequently in the dorsal region where it is more stable than either the cervical or lumbosacral regions. The most common site is the lumbosacral region and in recent years, chiefly due to the work of Bertilotti, considerable attention has been directed to this site. Variations in the cervical region, although comparatively rare, are varied and frequently multiple; nevertheless, they fall into two main types: (1) the numerical reduction of the cervical vertebræ in which the main clinical picture is a short neck without or with only a minor degree of torticollis, an anomaly usually associated with the names of Klippel and Feil and known in the European literature as Klippel-Feil syndrome; and (2) congenital torticollis of vertebral origin in which the shortening of the neck is of small import compared with the torticollis. The first of the two types will be discussed here. Only about thirty such cases are recorded in the literature and only one has been recorded in this country. All European countries have reported cases, but the French by far the greatest number. We wish to record two cases which have been observed in the Mayo Clinic within the last twelve months.

Historical.—The historical description of congenital anomalies of the cervical spine may be studied from two points of view, the anatomic and the clinical. Anatomic variations in this part of the spine have been noted and described by anatomists for many years. Columbus, in 1792, appears to have been the first; his description was soon followed by that of Morgagni. They both believed there were two types of fusion of the upper cervical vertebræ, the congenital and the acquired: the acquired the result of an inflammatory process, such as tuberculous disease or spondylitis, and the congenital, embryonic in origin, and associated wtih other congenital defects. Elliot Smith, in 1908, recorded twelve cases of fusion of the atlas to the occipital bone, six of which were compiled by Wood Jones from the cemeteries of lower Nubia, five from ancient Egyptian cemeteries, and one from the anatomical department of the medical school at Cairo. Macalister, in the anatomical collection at Cambridge, found occipito-axial fusion in 14 per cent. of skulls, and Franck-Russell found 4 per cent. of 455 skulls of ancient and modern Americans in the Peabody Museum at Harvard. Gladstone and Wakeley, in 1925, record seven cases of congenital anomalies of the cervical

spine among the specimens in the museum of King's College. In two of these cases there was a fusion of the atlas with the occipital bone, and in five an occipital vertebra.

The clinical records of such cases are much more recent. The earliest clinical description appears to be that of Jackson Clarke, who read the notes of a case before the Clinical Society of London. The patient was a boy, aged four years, whose chin, since birth, had been very close to the sternum; the head was fixed so that there was no movement of the cervical spine. The röntgenogram showed extensive bony abnormalities of the upper dorsal and cervical regions and a cervical rib on each side. The details of the operation are not given, but the child was said to have been improved. In 1912, the classical case of Klippel and Feil was described with extensive clinical and pathologic detail. The patient was a tailor aged forty-six, whose head appeared to be resting on the trunk as if from suboccipital Pott's disease, the hair was implanted low and all movements of the head were greatly limited. He died in the hospital from pulmonary congestion and nephritis. At necropsy the thoracic cavity was normal but the spinal column showed considerable variations from normal and could be divided anatomically into three portions: (1) a cervicodorsal mass with a spina bifida posteriorly; this mass possessed neither atlas nor axis and was probably formed by four dorsal vertebræ; (2) the dorsal vertebræ, eight in number and normal in shape, the first being fused to the cervical mass; and (3) the lumbar spine made up of four vertebræ, the fifth one being fused to the sacrum. In reviewing the vertebral column as a whole, there were only twelve well-differentiated vertebræ, four lumbar and eight dorsal, in place of the normal twenty-four. There were twelve pairs of ribs; each of the eight dorsal vertebræ possessed one pair, and the cervicodorsal mass possessed four pairs, described as cervical ribs. Since this classical description, numerous cases have been recorded in the literature, especially the French and Italian. In 1919, Feil compiled all the reported cases and published them in the form of a thesis.

Morphology and Anatomy.—From the point of view of development the skull is divided into two parts, the preotic and the postotic. The preotic, or non-vertebral part, is the anterior, and is regarded as a new formation to receive the greatly developed brain and afford protection to the organs of sight and smell. The postotic part is posterior and is of vertebral origin; the more anterior sclerotomes have been fused together to form this portion of the skull. According to Froriep, the mammalian occiput corresponds to the fusion of four vertebræ and probably in some classes of vertebrates the occipital region of the primodial cranium is increased by fusion of the upper cervical vertebræ with a consequent diminution in length of the cervical region. In the course of evolution, the craniovertebral articulation appears to have been shifted backward, one vertebra after another having been absorbed into the skull to form the postotic segment. Many anatomists consider congenital fusion and assimilation of the atlas into the occipital bone a further stage in the process of evolution, but when the vertebral column is considered as a

whole in such cases, it is found sometimes to be actually lengthened. After the original error there is a tendency for the spine to assume the normal proportions.

Atlanto-occipital Fusion.—Swjetschnikow, some years ago, made a careful study of this anomaly and published a very complete monograph on the subject. He divided the condition into three types: (1) those acquired as the result of tuberculosis, syphilis or arthritis; (2) those acquired by the fetus in utero as the result of pressure in an abnormal pelvis, and (3) those purely congenital, in which, during the process of growth, the sclerotomes which develop into the cranium become abnormally attached to the sclerotome of the first cervical segment. The first type will not be considered here as it is entirely an acquired disease. The second type is known as the basilar kyphos of Virchow, and is characterized by a circular depression around the foramen magnum in which the condyles are situated. The occipital bone is pushed downward, taking with it the mastoid processes, and overhangs the first cervical vertebra. Several theories exist as to the nature of this type of abnormality. Bertilotti regards it as a congenital malformation of the cervical spine; Schultzness and Meyer believe it is caused by muscular action, and Virchow and Grawitz that it is due to loss of bony substance. The third type, which is an occipitalization of the atlas, may exist without other anomalies, but it is frequently accompanied by other malformation such as hæmivertebra, numerical reduction of the vertebra, and spina bifida. It is the most frequent cause of osseous torticollis and may occur in a unilateral or a bilateral form. If unilateral the head is inclined to the occipitalized side, the degree of the torticollis depending on the gravity of the fusion. The head is not always fixed and there is often some contracture of the muscles of the neck, thus combining a muscular and an osseous torticollis. If the form is bilateral, the symmetry is rarely perfect, so that there is often a minor degree of torticollis. This

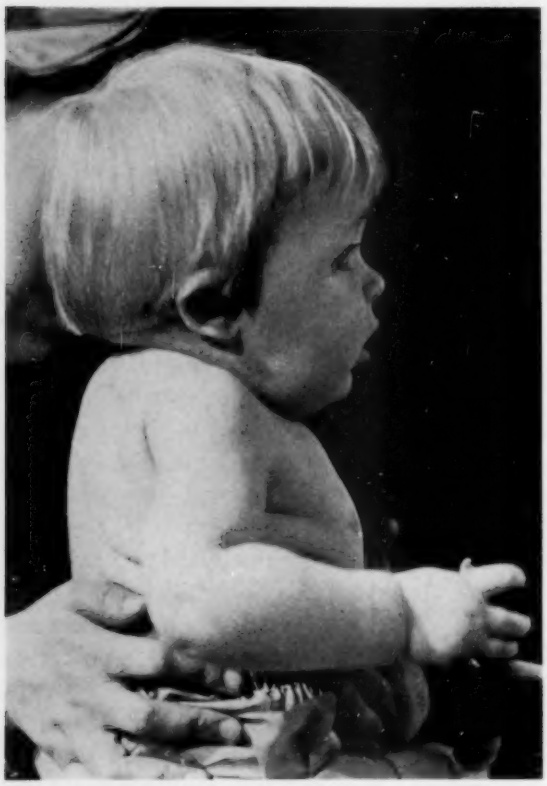

FIG. 1.—Photograph taken in lateral position, showing the shortness of the neck.

condition is not always noticed at birth, but usually becomes apparent between the fifth and tenth years of life.

Clinical Manifestations.—The clinical picture of this disease has changed but little since the classical description of Klippel and Feil in 1912. The condition is not incompatible with long life as it has been noted in persons seventy years of age. Heredity does not appear to be an influence, nor are there any familial characteristics. The compiled records show that it is more common in males than in females.

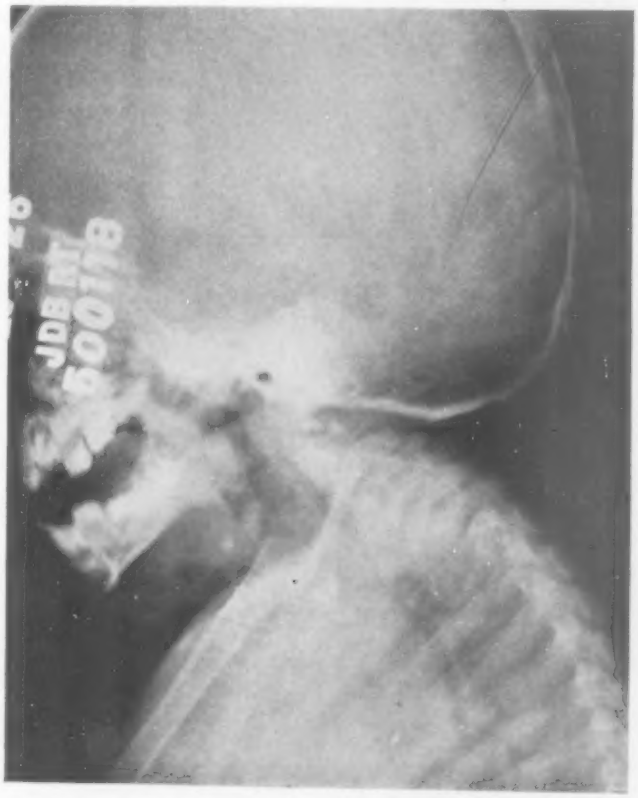

FIG. 2.—Röntgenogram showing that two cervical vertebræ are missing.

The symptoms may be divided into primary and secondary. The primary symptoms are shortening of the neck, low implantation of the hair and limitation of the movements of the head. The head appears to sit directly on the top of the thorax, in many cases as if there were no neck. The hair extends directly onto the thorax, and in consequence of the osseous anomalies there is considerable limitation of the movements of the head. The secondary characteristics are the direct result of the altered relationship between the shoulder girdle and the thoracic cavity. The back is generally round, with varying degrees of scoliosis, due to the fact that the thorax has risen to the occiput. With the rising of the thorax the nipples assume a slightly lower level than normal. The scapulæ, unlike the nipples, rise with the thorax, and this, together with the disproportion between the length of the limbs and the trunk, give a simian appearance to the patient. The chin sits directly on the sternum, and is frequently underdeveloped. The opening of the mouth is restricted and the teeth frequently grow in an oblique direction. There may or may not be a spina bifida. If there is a gap in the posterior arches of the cervical vertebræ it is not a true spina bifida, but merely an arrested development and purely an osseous lesion. It corresponds

to the so-called spina bifida occulta which is so common in the first sacral segment. In all the recorded cases of the Klippel-Feil syndrome, there is a complete absence of all nervous and cutaneous lesions. The head as a rule is not quite straight, and there is generally a minor degree of torticollis.

Etiology.—Many hypotheses have been put forward to explain congenital anomalies of the spine; such anomalies are rarely single but are generally associated with variations in other parts of the body. Variations in one part of the spine are very frequently compensated for by variations in another part. Gladstone and Wakeley seem to us to have provided the simplest explanation. They regard congenital variations not as a regressive or progressive tendency in philogeny, but rather as the result of a morbid condition interfering with the normal development of the fetus. Many of the variations cannot be classified as defects, for frequently an additional part, such as a cervical rib or a supernumerary digit is formed. The normal tendency of the parental stock to transmit is weakened and it is unable to produce a like offspring. An unstable condition in the development of the fetus is produced which induces variations in development. These unstable conditions may be produced by unhygienic conditions or disease affecting either parent.

FIG. 3.—Anteroposterior position.

Röntgenology.—When röntgenograms of this condition are taken certain definite positions must be used to bring out the anomalies. These positions have been very carefully studied and described by Feil. Röntgenograms should portray first the spine as a whole, so as to give a general idea of the sites of anomaly, and, second the local condition and relations of the cervical segments. In pictures of the spine as a whole, three positions are necessary: An oblique anterior taken from the right or left, an anteroposterior, and a lateral. Localized röntgenograms should be taken through the mouth and by axial projection from the base of the skull in order to get images of the atlas and axis, and the occipitovertebral and allanto-axial articulations.

Pathologic Anatomy.—Very few actual pathologic specimens have been studied; most of our knowledge of the pathologic anatomy of this disease is

based on röntgenologic examinations. Considerable variations are shown, from the absence of a single cervical vertebra to complete absence of the cervical spine. Feil recognized three types: complete absence of the cervical spine; partial numerical reduction of the cervical vertebra, and partial reduction not confined to the cervical vertebræ, but extending throughout the whole spine.

In two-thirds of the cases, a large triangular opening occupies the posterior part of the vertebræ and in some cases extends from the cranium to the thoracic region. The thorax ascends to the skull, forming a cervical thorax. The atlas is often fused to the occipital bone and there is almost always a basilar or craniocervical kyphosis.

FIG. 4.—Lateral position.

REPORT OF CASES

CASE I.—A male child, aged fourteen months, was brought to the Mayo Clinic, March 25, 1925, on account of shortness of the neck. At his birth the parents noticed that his neck was very short, and later that the rotation of the neck was greatly restricted. In July, 1924, the neck was röntgenographed by their home physician, who discovered that some of the cervical vertebræ were missing. There is no history of short neck in the family.

The baby was fat and healthy. Besides the very short neck and its limited rotation, there was also a cleft in the soft palate. Röntgenograms showed that two cervical vertebræ were missing. A diagnosis of Klippel-Feil syndrome was then made. (Figs. 1 and 2.)

CASE II.—A female child, aged three years, was brought to the Mayo Clinic, September 30, 1924, because of shortness of the neck. The parents had noticed that the neck had been abnormally short since birth. The child was otherwise healthy. Röntgenologic examination revealed an absence of two cervical vertebræ. A diagnosis of Klippel-Feil syndrome was made. (Figs. 3 and 4.)

CONCLUSIONS

Numerical reduction of the cervical vertebræ is a comparatively rare congenital anomaly, but undoubtedly is more common than the literature would lead one to believe. The clinical appearances of patients with this anomaly are characteristic. The pathologic changes may vary from absence of one or two cervical vertebræ to complete absence of the whole cervical spine.

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HORSESHOE KIDNEY*

By Daniel N. Eisendrath, M.D., Frank M. Phifer, M.D.
and
Harry B. Culver, M.D.
of Chicago, Ill.

Definition.—As stated in a previous article[1] we believe that the term "fused kidney" should be discarded. In its place we should employ the following terms to designate the respective conditions:

1. Crossed Ectopia.—To be used for those cases in which both kidneys

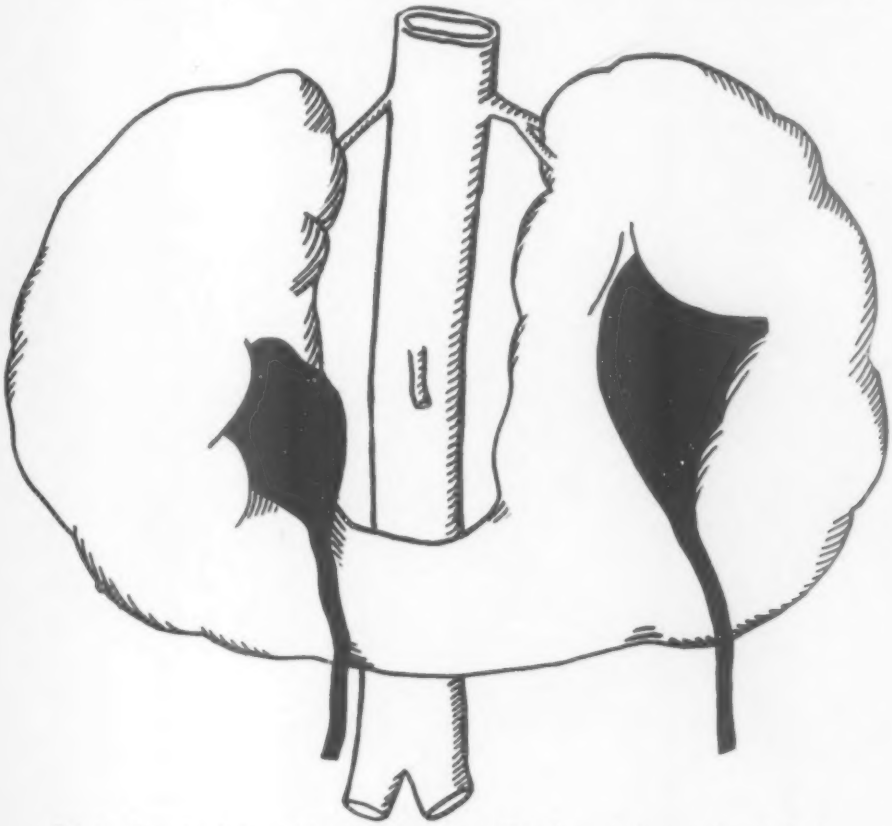

Fig. 1.—Horseshoe kidney with symmetric halves. (Drawing made from specimen in Rush Medical College Museum.)

are found on the same side of the body. They may be fused into one mass or be separated. The lower of the two kidneys corresponds to the one which in the embryo should have been found on the opposite side of the body.

2. Double Kidney.—To be used for those cases in which there is a reduplication either complete or incomplete of the ureter and a corresponding

*From the Cook County and Michael Reese Hospitals.

reduplication of the renal pelvis on one or both sides of the body. The parenchyma around the respective pelves of each half of the kidney may fuse, or the two halves may be more or less separated.

3. Horseshoe Kidney.—The two kidneys of opposite sides of the body are connected across the spine by an isthmus which may consist only of

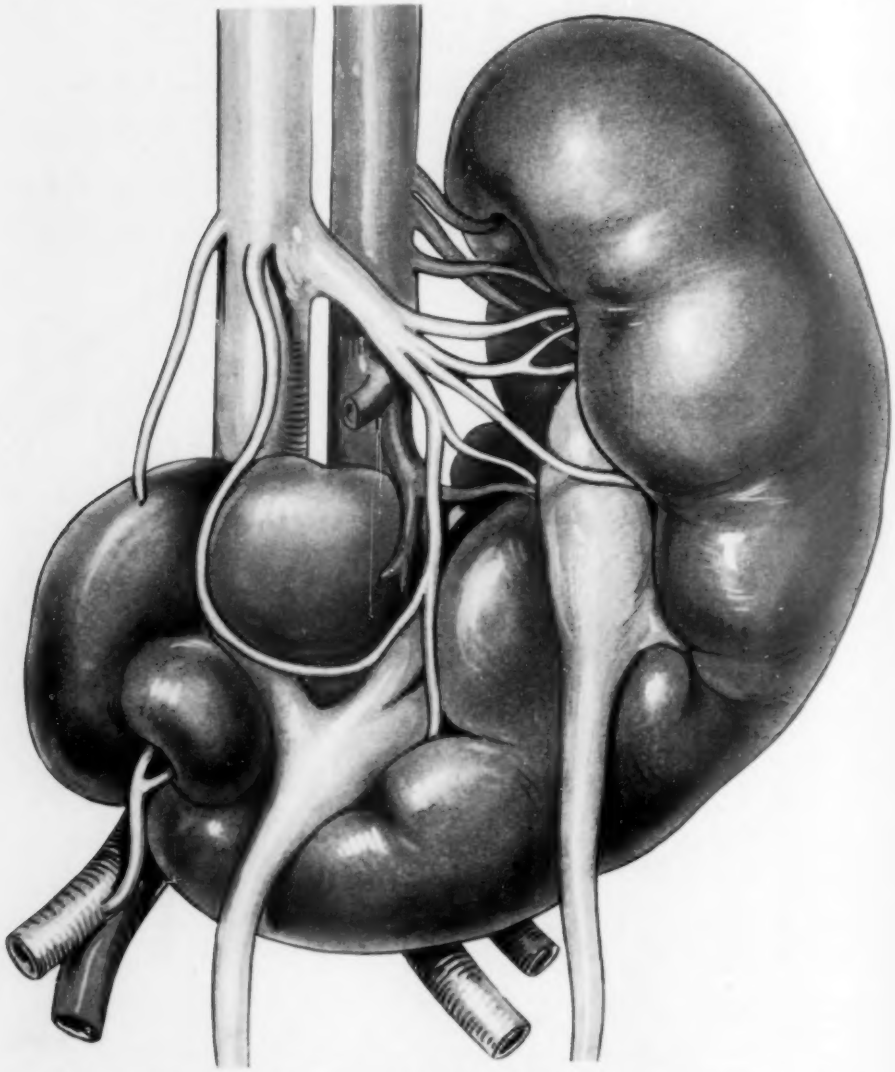

FIG. 2a.—Horseshoe kidneys with asymmetric halves. One-half at higher level. (Rush Medical College Museum.)

fibrous tissue or of parenchyma. The isthmus varies greatly in width and as to whether it connects the upper or lower poles.

4. Cake or L. Kidney.—These are simply sub-varieties of the horseshoe kidney. If the isthmus which extends across the spine is so wide that it connects the two kidneys along their entire mesial borders, we speak of a cake

kidney. (Fig. 7.) If one-half of the horseshoe kidney is elongated so that the other half only is united to its lowermost portion, we speak of an L. kidney. (B of Fig. 2.)

1. *Frequency of Horseshoe Kidney.*—Botez [2] collected the statistics of

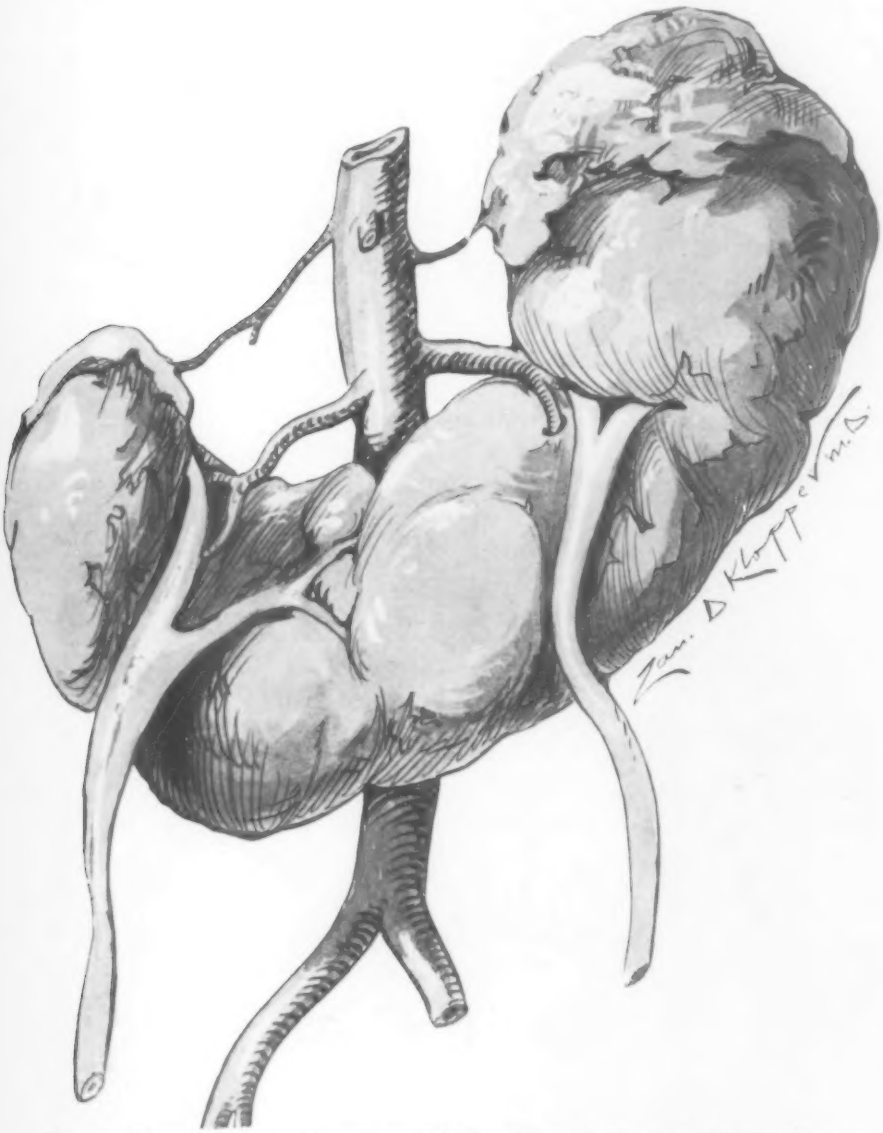

Fig. 2b.—Horseshoe kidneys with asymmetric halves. The two halves form an L-shaped mass. (Garre and Ehrhardt case.)

51,504 autopsies published by various authors up to 1912. Horseshoe kidney was found in 72 of these, or 1 to 715 autopsies. Carlier and Gerard,[3] in 1913, added some later observations to those of Botez, finding that this anomaly occurred eighty times in 69,989 autopsies or 1 to 862. Since 1913,

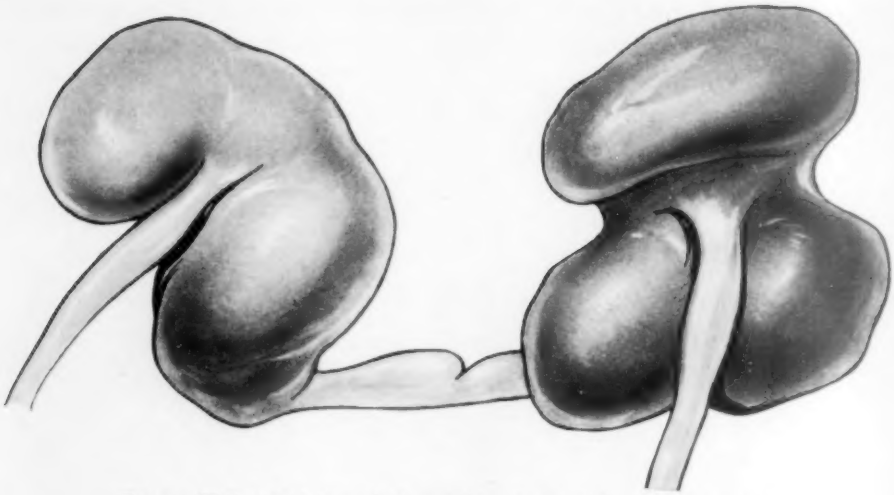

FIG. 3.—Well marked fibrous isthmus joining the two halves. (Küster case.)

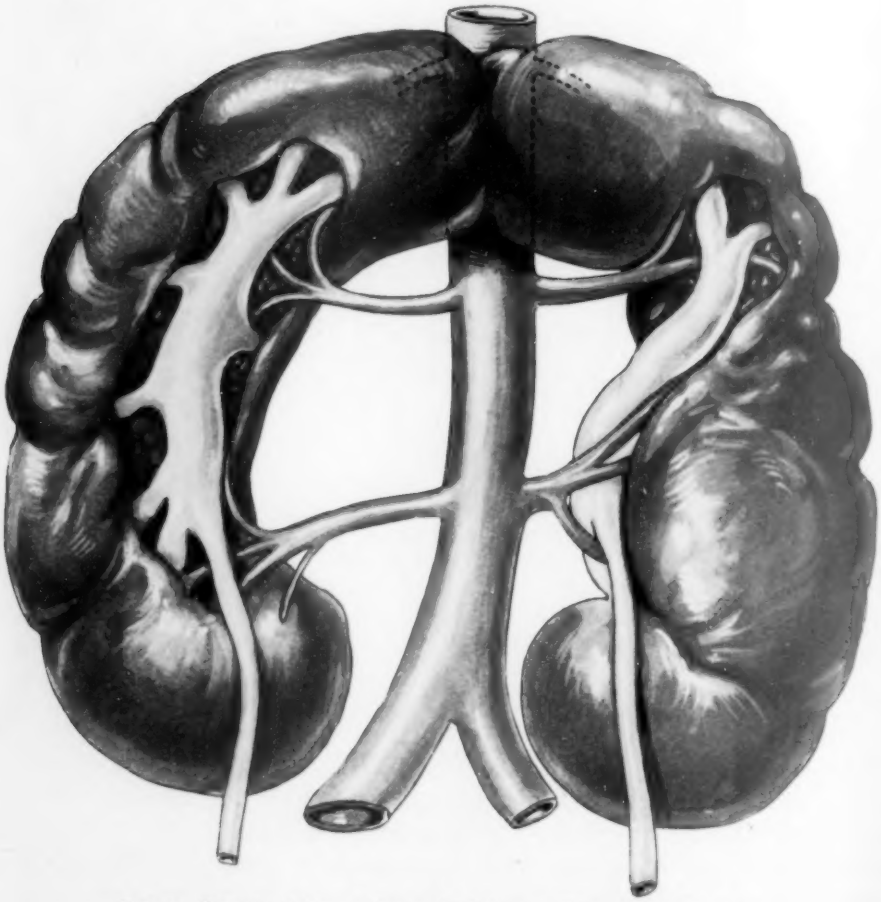

FIG. 4.—Horseshoe kidney with superior isthmus. (Byron Robinson case.)

the observation of Motzfeld [4] can be added, making a total of 73,489 autopsies in which horseshoe kidney was found in 92, or approximately 1 in 710 bodies.

2. *Relation of the Two Halves.*—Horseshoe kidneys may be divided as follows:

1. Symmetric.—Both halves approximately equal in size and at the same level. (Fig. 1.)

2. Asymmetric.—Inequality in size and level of the two halves. (Fig. 2.) One side may be hypoplastic and the other the size of a normal kidney, or one side may be of normal size and the other so elongated as to form together a V or L-shaped mass. (Fig. 2.)

Fig. 5.—Isthmus composed of both cortex and medulla. The isthmus joined the upper poles. (Baetzner case.)

As a rule the two halves are situated an equal distance from the spine, but it is well to remember in our radiographic study of suspected cases that one or both halves may be as far away from the spine as is the normal kidney, or on the other hand, that one-half may be quite close to the spine and the other not. (Fig. 14.) It is not uncommon to find a hypoplasia of one-half and a compensatory increase in size of the other half. As a rule the lower poles converge, as is true in the embryo (Broman) and hence the renal shadows and pyelograms or calculous shadows (Fig. 15) are often directed obliquely inwards. The upper poles in some cases are very far apart and the angle which the halves form with the spine wider than when the upper poles are a normal distance apart.

3. *The Isthmus, etc.*—(a) Inferior and superior. Byron Robinson [5] found the isthmus joining the lower poles in 88 per cent. of his observations. Beyer [6] found such an inferior isthmus in 93 per cent. and Gerard in 91 per cent., so that one can say that it is so located in about 90 per cent. of the cases. The superior polar isthmus occurs in the remaining 10 per cent. (See Fig. 3.)

(b) *Width and Character of Isthmus.*—This was fibrous in (Fig. 4) seven cases. Robinson (*loc. cit.*) estimates that this condition exists in 15 per cent. of all cases, but this appears too high a percentage. In the majority of cases the isthmus is composed of parenchyma, so that there is no demar-

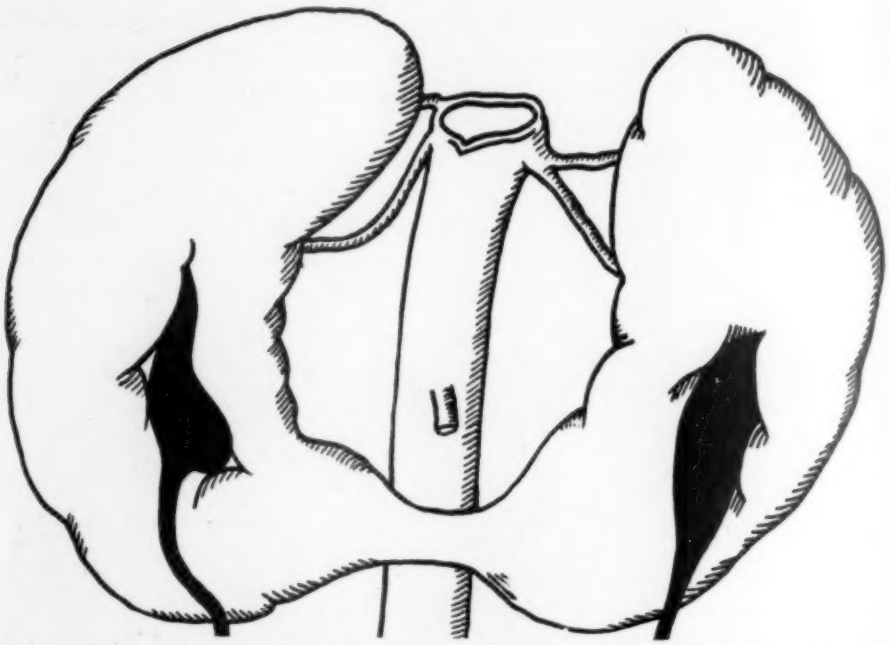

FIG. 6a.—Specimen in Rush Medical College Museum, illustrating variation in width of isthmus. Compare with Figs. 3, 6b and 7 to understand how the cake kidney originates.

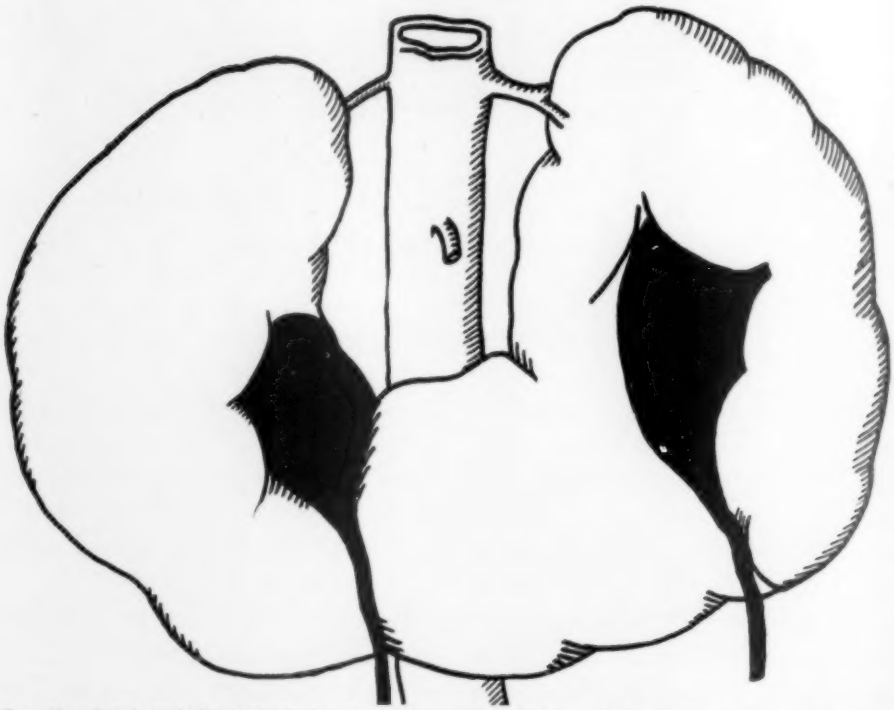

FIG. 6b.—Specimen in Rush Medical College Museum, illustrating variation in width of isthmus. Compare with Figs. 3, 6a and 7 to understand how the cake kidney originates.

cation between the two halves. (Fig. 5.) The isthmus in a vertical direction measures from 2 to 3 cm. in the majority of cases.

(c) *Transition to Cake Kidney.*—The isthmus may unite a variable proportion of the two halves, as a rule only the poles, but it may fuse together more than the 2 to 3 cm. just mentioned so that all degrees (Fig. 6, a and b) are found up to that of complete fusion to which the name cake kidney (Fig. 7) has been given. Here there is a solid mass of renal tissue without any mesial demarcation.

(d) *Relation of Isthmus to Aorta.*—In only two cases, *viz.*, those of Nixon [7] and Kelly [8] was the isthmus behind the aorta.

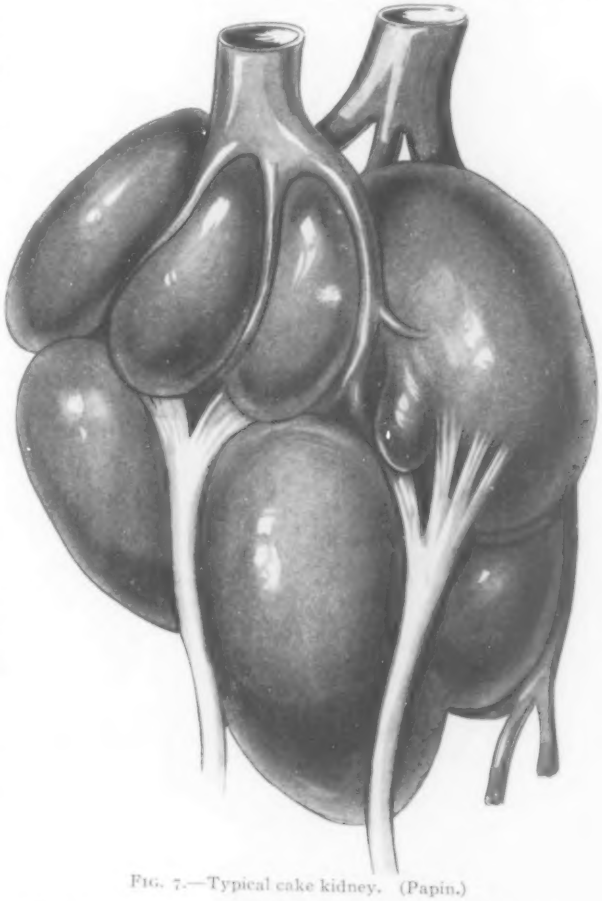

FIG. 7.—Typical cake kidney. (Papin.)

4. *Renal Pelves.*—In the majority of cases there is a single pelvis on each side. (Fig. 1.) Reduplication of the ureters and of the pelves on one or both sides is not rare. (Fig. 8.)

The pelvis is usually on the anterior (ventral) aspect of the kidney (Fig. 1) at the level of the normal hilus and resembles that of the normal organ in respect to being a single cavity with its calyces, located either partly external to the hilus or not extending beyond it; *i.e.*, intrarenal. In horseshoe kidney a true pelvis of this kind is often absent, the calyces being all extrarenal and ending independently in the ureter. (Fig. 9.)

5. *Ureters.*—As a rule the ureters pass across the front of the isthmus and this accounts for the frequency with which calculi, hydronephrosis, etc., occur. Robinson found that the ureters passed behind the isthmus (Fig. 10) in 9 per cent. of his specimens, but this figure would seem too high inasmuch as only two reports, *viz.*, those of Landouzy [9] and Durham [10] have been published of ureters behind the isthmus. The latter according to Robinson and other observers, at times has an independent ureter. In Karl Joseph's case this isthmian ureter ended independently in the bladder. Perruchet [11]

describes a case in which one ureter passed behind the other in front of the isthmus. As a rule calyces are only present in the upper two-thirds of each half, but an extrarenal calyx or an independent ureter may drain the isthmus (Fig. 9) and be opened during the operation of division of the isthmus or of heminephrectomy. The ureters usually end in the bladder at the normal location, but it must be remembered clinically that one ureter may end ectopically (Fig. 11) as is so often the case in double kidneys.

6. *Location of Horseshoe Kidney.*—This is usually lower, just above the aortic bifurcation (Fig. 1), but it may be anywhere from the normal level of

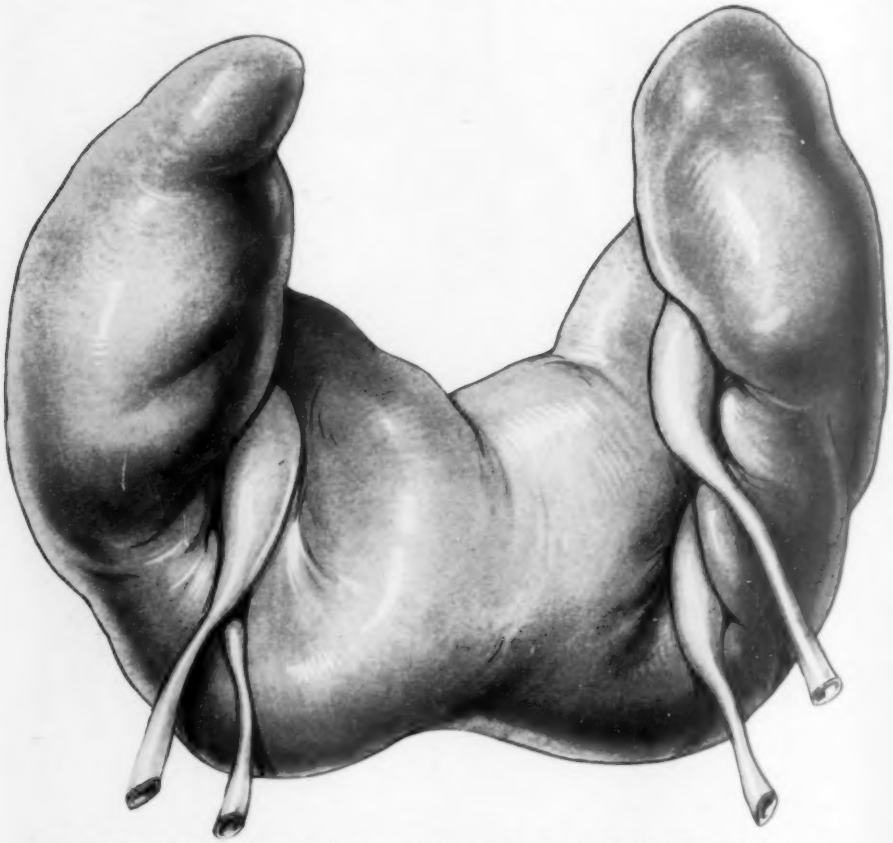

FIG. 8.—Horseshoe kidney with two ureters and two pelves for each half. (Byron Robinson case.)

the kidneys to the true pelvis. (Fig. 12.) Such a pelvic ectopia is not uncommon. Only seven cases are reported in which the isthmus was at the normal level of the lower poles. In Rathbun's [12] case one-half of the horseshoe kidney was in the true pelvis. The majority of horseshoe kidneys which lie in the true pelvis are of the cake (Fig. 7) variety, *i.e.*, have completely fused halves. The isthmus is usually at the level of the fourth to fifth lumbar vertebræ and may not be in the median line. There is very little mobility as a rule in a horseshoe kidney, but a few cases have been reported in which marked mobility existed. The fixation of a horseshoe kidney is in great

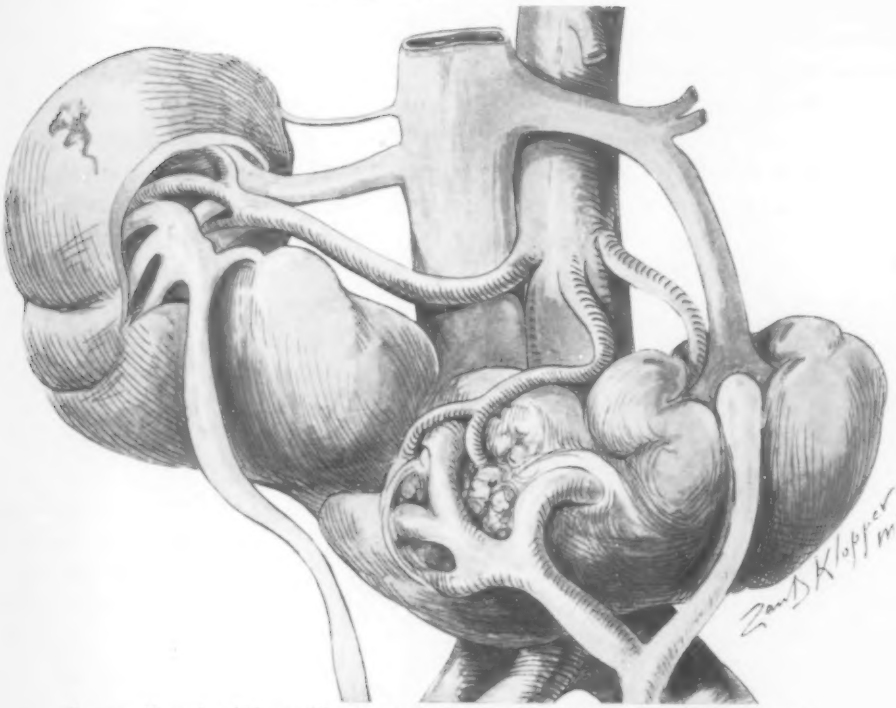

FIG. 9.—Horseshoe kidney with extrarenal calyces ending directly in left half, into ureter.
(Rush Medical College Museum.)

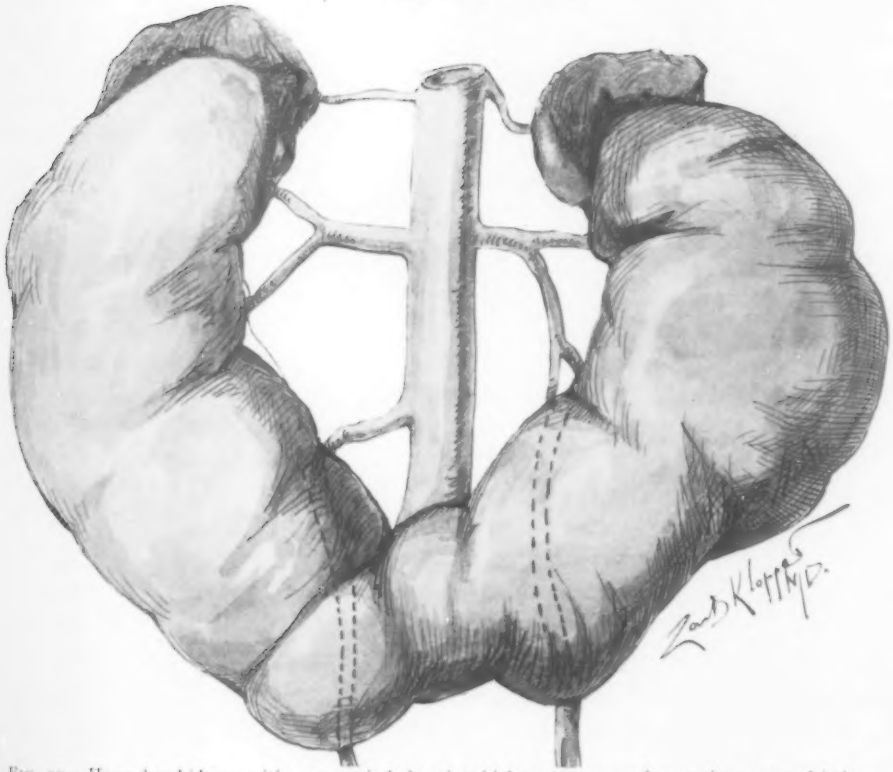

FIG. 10.—Horseshoe kidneys with symmetric halves in which ureters crossed posterior aspect of isthmus.
(Rush Medical College Museum.)

measure due to the fact that it has multiple blood-vessels supplying it; all from immediately adjacent trunks. There is but little perinephric fat, hence this does not play a rôle in fixation of the horseshoe kidney.

7. *Blood Supply.*—It is important from the operative standpoint to remember that multiple arteries and veins for each half and often for the isthmus as well, are found in eighty per cent. In a study of 139 cases, including 10 of his own, Papin[12] found the following:

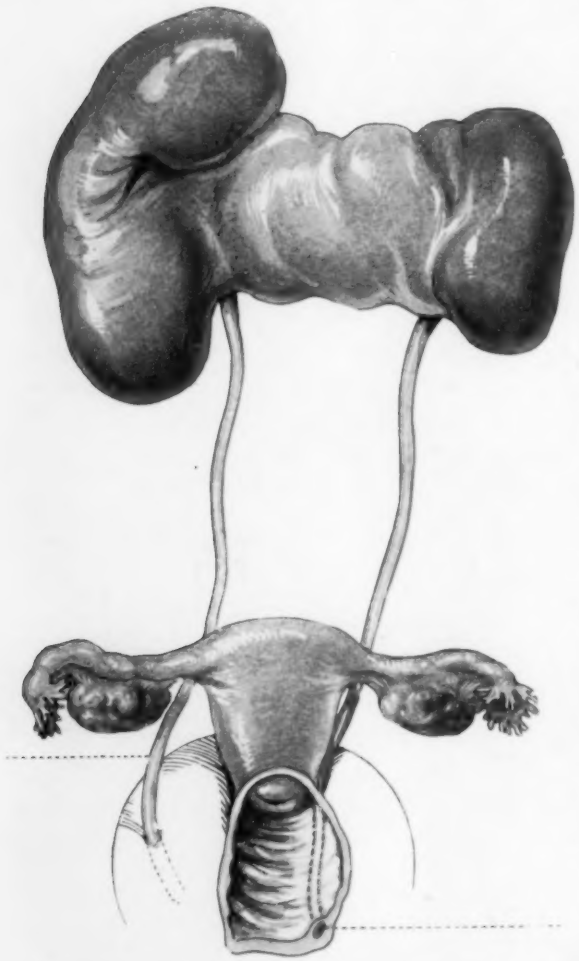

FIG. 11.—Horseshoe kidney with relatively wide isthmus. One ureter ends just below external meatus. (Female.) (Massari case.)

(a) A single artery for both halves in only one case. (Bruncher.)

(b) One artery for each half in 25 cases. (A of Fig. 13.)

(c) One artery for each half and one for the isthmus. (B of Fig. 13.) This is almost the normal condition. There were 40 cases in this group.

(d) Two arteries for each half and one for the isthmus. (C of Fig. 13.) The one for the isthmus is an aortic branch. There were 26 cases in this group.

(e) Two arteries for each half and one or two for the isthmus. The former are given off by either the aorta or the common iliacs. The latter (isthmic branches) arise from the iliacs. (C of Fig. 13.) Twenty cases belonged to this group.

In the remaining groups there were from six to eight arteries for the two halves. The important deductions are that one must have an adequate exposure of the operative field because (a) of the multiplicity of the vessels, both arteries and veins, which supply both halves and the isthmus, and (b) because they may arise from the aorta or end in the vena cava, respectively, or similarly from the iliacs.

CLINICAL IMPORTANCE OF HORSESHOE KIDNEY

1. *Factors Favoring Pathologic Conditions.*—(a) Course of ureter across isthmus. This is perhaps the most important, because of the sharp bend which must be made by the ureter across the more or less thick and hard isthmus. (Fig. 1.) Infections of the kidney involving the ureter secondarily are more apt to cause obstruction through fixation and kinking than in the case of the normal ureter.

(b) The abnormal location of the pelvis on the ventral aspect of the kidney and the fact that the ureteral insertion is often at a higher point than the bottom of the pelvis and the frequent absence of a pelvis proper (Fig. 9), all favor stagnation of urine and subsequent infection. (Figs. 17 to 20.)

(c) The frequent occurrence of congenital strictures of the ureter in horseshoe kidneys.

(d) The presence of many accessory vessels and the possibility of ureteral obstruction by them.

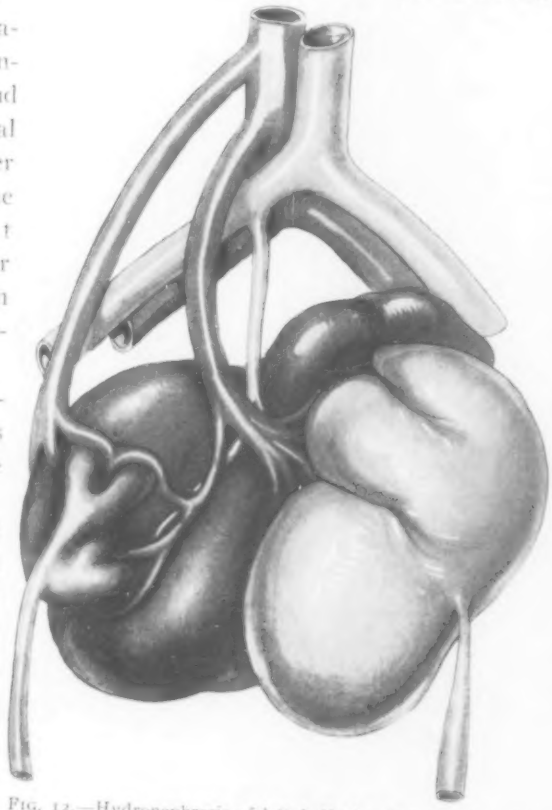

FIG. 12.—Hydronephrosis of left half of pelvic ectopic cake kidney. (Heiner.)

2. *Published Clinical Cases.* Botez (*loc. cit.*) collected all clinical reports up to 1912 and included several unpublished ones (Marion) in his article. Of a total of fifty of Botez's cases, only 39 are of value from the operative standpoint. Since 1912, we have found reports of ninety additional clinical cases and with our own, reported in this article, we have a total of 132 up to July, 1925. (See Tables I to VII inclusive.)

We will report our three cases before taking up the subject any further.

CASE I.—*Pyelotomy for renal calculus in one-half of a horseshoe kidney. Presence of this anomaly diagnosed before operation.*

Male, aged thirty-two, complained of pain in right lumbar region radiating to right upper quadrant of abdomen, of two days' duration. In addition to tenderness over the right iliocostal space, there were other evidences of acute renal infection. Radiography (Dr. Cora M. Matthews) revealed an oval vertical shadow (A of Fig. 14) lying over the transverse process of the second lumbar vertebra; *i.e.*, closer to the spine than shadows of renal or ureteral calculi usually do. The right opaque catheter curved slightly out-

TABLE I

Division of Isthmus Alone (Symphysiotomy) or Combined with other Operations

Case No.	Author and reference	Sex and age	Chief clinical data	Operation	Remarks
1.	E. Papin: Assoc. franc. d'Urologie, 22nd Congress, Paris, Oct. 22, 1922, p. 557	Female 32 years	Gradually increasing abdominal and lumbar pains. Could feel isthmus and confirmed diagnosis by pyelography. Both pelves lower, with calyces directed towards midline	Ureter in front of the 2 cm. isthmus on both sides. Division of isthmus was easy. Extraperitoneal approach	Complete relief of pain. Diagnosis of horseshoe kidney made by pyelography.
2.	Martinow: Zent. f. Chir., 9, 314, (Feb.) 1910	Female 49 years	Recurrent attacks of pain above level of umbilicus where could palpate tender mass	Transperitoneal division of isthmus	Complete relief of pain. Diagnosis of horseshoe kidney made by palpation alone.
3.	Rovsing: Zeit. f. Urol., 5, 586, 1911	Male 23 years	Recurrent attacks of girdle-like pain at level of umbilicus. Disappeared when in recumbent position. Could feel mass running obliquely across abdomen	Crushed isthmus by transperitoneal route	Complete relief of pain. Diagnosis made by palpation alone.
4.	Malinowsky: Jour. d'Urologie, 1, 869, (Dec.) 1912	Female 28 years	Persistent abdominal pain, accompanied by hyperacidity. Could palpate isthmus	Crushed isthmus	Complete relief of pain, but not of hyperacidity. Diagnosis made by palpation alone.
5.	Mintz: Chirourg. Archiv. Veliam, 29, 1047, 1923. Quoted by Papin: Arch mal. des Reins, 2, 24, Feb. 1, 1925	Female 33 years	Recurrent attacks of non-localizable abdominal pain. Felt mass size child's head at level of umbilicus	Transperitoneal division of isthmus	Complete relief of pain. Diagnosis of horseshoe kidney not made before operation.

6.	Brongersma: Zeit. f. Urol., 8, 477, 1914	Female, age not given	Recurrent pain, (bilateral) resembling ureteral colics	Transperitoneal division of isthmus	Complete relief of pain. Diagnosis not made before operation.
7.	*Idem.*	Male, age not given	Pain at level of umbilicus especially upon leaning forwards. Hæmaturia once after lifting heavy weight	Transperitoneal division of isthmus	Complete relief of pain. Diagnosis of horseshoe kidney made at previous abdominal operation.
8.	Eggers: Zeit. f. Urol. Chir., 9, 427, 1922	Male 18 years	History of left-sided renal calculus, confirmed by radiography. Pyelography after operation revealed both pelves close to spine	Extraperitoneal division of isthmus with fixation of left half after pyelotomy for multiple calculi	Recovery. Diagnosis made during operation.
9.	Kroiss: Verh. d. Deut. Gesell. f. Urologie, 1922	Female 29 years	Recurrent severe pain at level of umbilicus. Palpable mass below this level. Pyelography reveals both pelves much lower than normal	Transperitoneal division of isthmus	Complete relief of pain. Possibility of horseshoe kidney considered before operation.
10.	Kidd: Proc. Royal Soc. Med., London, 15, 52, 1922	Female 32 years	Recurrent attacks of severe pain over sacral region. Very mobile kidney to be felt in right iliac fossa	Transperitoneal division of isthmus	Complete relief of pain. Diagnosis made during primary operation for supposed mobile kidney.
11.	Van Houtem: Zeit. f. Urol. Chir., 8, 165, 1922	Female 37 years	Recurrent attacks of colicky pain in back and over abdomen, accompanied by hæmaturia. Pyelography revealed one pelvis close to spine	Transperitoneal division of isthmus	Gradual disappearance of pain. Diagnosis made by palpation under anæsthesia and confirmed by pyelography before operation.
12.	De Groot: Zeit. f. Urol. Chir., 8, 170, 1922	Male 16 years	Recurrent severe abdominal pain which disappeared when in recumbent position. Could feel mass above and to left of umbilicus	Transperitoneal division of isthmus	Complete relief of pain. Diagnosis made during exploratory laparotomy.

TABLE II

Heminephrectomy Alone

Case No.	Author and reference	Indication for operation and remarks
1	Barth (Israel): Arch. Klin. Chir., 74, 368, 1904	Tuberculous hydronephrosis of right half.
2	Clairmont: Arch. Klin. Chir., 79, 667, 1906	Hydronephrosis in two-year-old child.
3	Hoffman: Wien. Klin. Woch., 122, 355, 1913	Tuberculosis. Recovered.
4	Marjasches (see Kobylinski)	Same as No. 3. Died p.o.
5	Koenig: Deut. Zeit. Chir., 40, 92, 1895	Sarcoma in child.
6	Gibbon: Rev. de Chir., 1265, 1909	Same.
7	Debuchy (see Kobylinski): Folia Urol., 6, 160, 1911	Carcinoma.
8	Rumpel: Zent. Chir., 29, 1091, 1902	Calculous pyonephrosis.
9	Lotheissen: Arch. Klin. Chir., 52, 768, 1896	Hydronephrosis secondary to ureteral stricture. Died p.o.
10	Paschkis: Wien. Med. W., 60, 2417, Oct., 1910	Calculous pyonephrosis.
11	Kümmell: Case 2. (Flockemann) Zeit. Urol. Chir., 4, 204, 1918	Hydronephrosis. Recovered.
12	Kümmell: Case 4. (Flockemann), *Idem.*	Calculous hydronephrosis. Recovered.
13	*Idem:* Case 5. *Idem.*	Chronic nephritis. Recovered.
14	Faykiss: Wien. Med. W., 60, 1479, 1914	Tuberculosis. Recovered.
15	Hildebrandt: Zeit. f. Urol., 14, 465, 1920	Sarcoma.
16	Albarran: Ann. Mal. Genitourin, 25, 801, 1907	Hydronephrosis. Recovered.
17	Legueu: Necker Clinics, 1922	Tuberculosis.
18	*Idem.*	Echinococcus.
19	Renton: Brit. Med. Jour., 1, 601, May 20, 1920	Calculus with atrophic pyelonephritis.
20	Leedham-Green: Brit. Med. Jour., 2, 1583, Dec. 20, 1923	Pyonephrosis.
21	*Idem.*	Same.
22	Bryan: Virg. Med. Month., 48, 75, May, 1921	Hydronephrosis. Pyelogram (post-operative) showed median pelvis.

TABLE II—*Continued*

Heminephrectomy Alone

Case No.	Author and reference	Indication for operation and remarks
23	Rawling: Brit. Jour. Surg., 9, 162, 1921	Bilateral nephrolithiasis. Heminephrectomy for calculous pyonephrosis.
24	Thompson: ANNALS OF SURGERY, 54, 355, Sept., 1911	Pyonephrosis.
25	Harris (see Thompson)	Tuberculosis.
26	Rehling: Int. Jour. Surg., 32, 239, 1919	Hydronephrosis. Recovered.
27	Magnus: Zent. f. Chir.	Tuberculosis. Died seven weeks after operation.
28	Jeck: Int. Jour. Surg., 32, 639, 1919	Pyonephrosis.
29	Judd, Braasch & Scholl: J.A.M.A., 79, 1189, Oct. 7, 1922	Ureteral calculus complicated by hydronephrosis.
30	*Idem.*	Infected hydronephrosis.
31	*Idem.*	Multiple calculi.
32	*Idem.*	Hydronephrosis.
33	Judd, Braasch & Scholl, *Idem.*	Infected hydronephrosis.
34	*Idem.*	Infected hydronephrosis.
35	*Idem.*	Infected hydronephrosis.
36	Oraison: Gaz. Hebdom., 40, 32, Feb. 9, 1919	Tuberculosis.
37	Nash: Lancet, 174, 1151, 1908	Hydronephrosis in 16 months child.
38	Bugbee & Losee: Surg. Gyn. & Obst., 28, 97, Feb., 1919	Tuberculosis.
39	Rathbun: Jour. Urol., 12, 612, Dec., 1924	Hydronephrosis. Died 17 days p.o. Diagnosis made before operation by pyelography.
40	*Idem.*	Calculous pyonephrosis.
41	Hess: Jour. Urol., 12, 267, 1924	Uretal calculus complicated by pyonephrosis.
42	Loeffler (Kroiss): Zeit. Urol. Chir., 16, 181, 1924	Infected hydronephrosis due to ureteral kink.
43	*Idem.*	Tuberculosis.
44	W. Carl: Zent. f. Chir., 50, 506, Mar. 31, 1923	Multiple calculi complicated by pyonephrosis.
45	G. Magnus: Zent. Chir., 54, 76, Jan. 24, 1925	Tuberculosis. Died 7 weeks p.o.

TABLE II—*Continued*

Heminephrectomy Alone

Case No.	Author and reference	Indication for operation and remarks
46	Leekahr: Ky. Med. Jour., 21, 679, Dec., 1923	Infected hydronephrosis.
47	Marson: Brit. Med. Jour., 1, 237, Feb. 10, 1923	Infected hydronephrosis complicating calculi (renal). Recovery.
48	Baltscheffsky: Finska. Lack. Handl., 64, 377, 1922	Tuberculosis. Recovery.
49	Israel: Fol. Urol., 1, 617, 1908	Hydronephrosis. Diagnosis before operation by palpation.
50	*Idem.*	Tuberculosis. Fistula persisted.
51	Zondek: Deut. Med. Woch., 46, 897, Aug. 5, 1920	Calculous pyonephrosis.
52	Bockenheimer: Berl. Kl. Woch., 48, 641, Sept. 4, 1911	Hydronephrosis in boy of six, due to ureteral kink.
53	Simon: Beitr. Klin. Chir., 26, 148, 1900	Sarcoma. Died two days p.o. of anuria.
54	Denk: Arch. Klin. Chir., 116, 245, 1921	Shadows of multiple calculi close to spine at level of 3rd to 4th lumbar vertebræ. Found calculous pyonephrosis of one-half of horseshoe kidney and resected. Isthmus at upper poles.
55	Karewski: Deut. Med. Woch., 47, 989	Infected hydronephrosis of one-half of horseshoe kidney with superior isthmus.
56	Key: Nor. Med. Ark., 47, 1, 1921	Hypernephroma.
57	Gibbon: Rev. de Chir., 1265, 1909	Sarcoma. Recovered.
58	Desmarest: J. de Chir., 5, 742, 1910	Calculous hydronephrosis. Recovery.
59	Enderlen: Presse Med., 357, 1910	Hydronephrosis. Recovery.
60	Marion: Unpublished but cited by Botez (*loc. cit.*)	Hydronephrosis. Recovery.
61	Michon: Assoc. Franc. d'Urol., 15th Session, 1911	Hydronephrosis. Secondary.
62	Oehlecker: Zeit. Urol. Chir., 10, 66, 1922	Hydronephrosis.
63	Rovsing: Zeit. f. Urol., 5, 586, 1911	Pyonephrosis. Suspected horseshoe kidney from palpatory findings.
64	Gayet: Jour. d'Urol.	Tuberculosis. Made diagnosis before operation by proximity of lower poles (palpation).

TABLE III

Pyelotomy or Nephrotomy

Case No.	Author and reference	Technic and remarks
1	V. Frisch: Proc. German Urol., Congress, 1911	Pyelotomy for calculus anuria. Calculus passed spontaneously later. Recovery.
2	Steiner, *Idem.*	Nephrotomy for two large calculi. Recovery. Suspected horseshoe kidney from palpatory findings.
3	Eisendrath: Surg. Gyn. & Obst., 15, 467, Oct., 1912	Hydronephrosis. Nephrotomy.
4	Israel: Fol. Urol., 1, 617, 1908	Diagnosis by palpation before operation. Bilateral pyelotomy for calculi.
5	Zuckerkandl (Paschkis): Wien. Med. Woch., 59, 2605, Oct. 30, 1909	Pyelotomy for calculus.
6	Perineau (Marion): Ann. Mal. Gen. Urin., 28, 427, 1910	Pyelotomy. Recovery.
7	Roth (Casper:) Berl. Klin. Woch., 48, 66, Jan. 9, 1911	Nephrotomy for calculus.
8	Adrian: Folia Urol., 8, 189, 1913	Pyelotomy for calculus.
9	Blesh: Jour. Okla. Med. Ass'n., 14, 239, Sept. 21, 1921	Ureterotomy for calculus. Ureter behind isthmus.
10	Krotoszyner: ANNALS OF SURGERY, 65, 565, 1917	Nephrotomy for calculus in case of bilateral renal calculus. Died on 3rd day after operation of uremia.
11	Renton: Brit. Med. Jour., 1, 601, May 20, 1920	Nephrotomy for calculus.
12	Taylor (Deaver): Am. J. Med. Sci., 161, 238, 1921	Transperitoneal route. Pyelotomy for large calculi.
13	Folsom: Texas St. Med. Jour., 16, 201, Sept., 1920	Pyelotomy for multiple small calculi.
14	Leedham-Green: Brit. Med. Jour., 2, 1583, Dec. 20, 1913	Pyelotomy for calculus.
15	*Idem.*	Pyelotomy for calculus.
16	Newman, Lancet, 2, 236, Aug. 18, 1917	Diagnosis by palpation before operation. Nephrotomy for calculus.
17	Judd, Braasch and Scholl: J.A.M.A., 791, 189, Oct. 7, 1922	Nephrotomy for calculus.
18	*Idem.*	Pyelotomy for calculus.
19	*Idem.* (Case 13)	Diagnosis made before operation from presence of shadows close to midline. Bilateral pyelotomy for calculi.
20	*Idem.* (Case 14)	Pyelotomy for calculus.

TABLE III—*Continued*

Pyelotomy or Nephrotomy

Case No.	Author and reference	Technic and remarks
21	*Idem.* (Case 15)	Diagnosis made before operation because of proximity of shadows and of one pyelogram to spine and anterior rotation of calyces. Bilateral pyelotomy for calculi.
22	Judd, Braasch and Scholl: Case 16, *Idem.*	Pyelotomy for calculus.
23	Kinard: J.A.M.A., 81, 2077, Dec. 22, 1923	Pyelotomy for calculus in one-half. Shadows present in opposite kidney but operation.
24	Eisendrath, Culver and Phifer (Present article), Case 1	Pyelotomy for multiple calculi. Diagnosis before operation from proximity of shadows to spine and pyelography.
25	Eisendrath, Culver and Phifer: (Present article), Case 2.	Same as above. Pyonephrosis of opposite half.
26	Schuchardt (See Paschkis): Wien. Med. Woch., 60, 2417, Oct. 8, 1910	Nephrotomy for calculus.
27	Winternitz: See abstract in Zent. Chir., 35, 314, 1908	Nephrotomy for multiple calculi.
28	Zondek: Deut. Med. Woch., Oct. 13, 1921, See orig. again	Pyelotomy for calculus. Diagnosis of horseshoe kidney made before operation by presence of shadows of both kidneys close to spine.
29	Voorhoeve: Jour. de Radiol., 3, 414, 1919	Pyelotomy for calculi. Diagnosis before operation from facts that both kidney shadows were close to spine, were vertical and both lower (at same level) than normal.
30	Rathbun: Jour. Urol., 12, 612, Dec., 1924	Pyelotomy for calculus. Post-operative pyelogram confirmed diagnosis horseshoe kidney made at time of operation.
31	Carlier: Memoires d'Urologie, July, 1911, Masson & Co., Paris	Resection of tuberculosis upper third of one-half. Recovery.
32	Lange: ANNALS OF SURGERY, 35, 581, 1901	Nephrotomy for calculi. Recovery.
33	Vince: Cercle Med., Brussels, 1902	Nephrotomy for calculus.
34	Walton: Ann. Genito-urin., 1802, 1910	Nephrotomy for calculus. Recovery.
35	Legueu: Traite Chirurg. d'Urol., 749, 1910	Pyelotomy for calculus. Recovery.
36	Reynard: Lyon Med., 132, 151, 1923	Nephrotomy for calculus.
37	Kraft: Fortsch. a.d. Geb. d. Roentgenstr., 29, 808, 1922	Nephrotomy for calculus. Possibility of horseshoe kidney considered before operation because of proximity of shadow to spine.

TABLE IV

Primary Pyelotomy or Nephrotomy and Secondary Heminephrectomy

Case No.	Author and reference	Operations and remarks
1	Gerard: Ann. mal. gen. urin., 29, 684, Apr., 1911	Pyelotomy for multiple calculi. Secondary heminephrectomy for pyelonephritis. Died p.o.
2	Kuster: Cited by Kobylinski, Folia Urolog., 6, 129, 1911	Pyelotomy for hydronephrosis. Secondary heminephrectomy.
3	Israel: Fol. Urol., 1, 617, 1908	Diagnosis before operation by palpation. Nephrotomy for intermittent hydronephrosis. Secondary nephrectomy.
4	*Idem.*	Nephrotomy for hydronephrosis.
5	Albarran: See Kobylinski	Same as above.
6	Socin: Beitr. Klin. Chir., 4, 197, 1888	Nephrotomy for hydronephrosis. Secondary heminephrectomy.
7	Boeckel: Jour. d'Urol., 12, 296, 1921	Pyelotomy for calculi. Secondary heminephrectomy for fistula due to ureteral calculus.
8	Socin: (See Case 3 Table III)	Primary nephrotomy for hydronephrosis. Secondary heminephrectomy. Death from hemorrhage.
9	Czerny-Nehrkorn Beitr. Klin. Chir., 31, 139, 1900	Nephrotomy for hydronephrosis. Secondary nephrectomy.
10	Winternitz: See Steiner, Zent. Chir., 28, 314, 1910	Bilat. Nephrolithiasis of horseshoe kidney. Nephrotomy for calculus followed by heminephrectomy on one side, nephrolithotomy on opposite side. Recovery.

TABLE V

Plastics or Ureterolysis on Horseshoe Kidneys

Case No.	Author and reference	Operation and remarks
1	Gregoire: Jour. d'Urol., 1, 659, 1914	Mobilized kinked ureter causing hydronephrosis of half of horseshoe kidney. Recovery.
2	Judd, Braasch and Scholl, (*loc. cit.*)	Division of isthmus with mobilization of ureter and rotation of right half in case of congenital hydronephrosis of one-half of horseshoe kidney.

wards, as it approached the shadow, but did not come in close contact with it (B of Fig. 14). The left opaque catheter followed a similar course, but turned inwards at a level corresponding to that of the right-sided shadow. The right pyelogram† (C of Fig. 14) revealed an elongated vertical pelvis close to the spine with an inferior calyx directed mesially, overlapping the disc between the third and fourth lumbar vertebræ. The left pyelogram was more laterally located, but also had a mesially directed calyx.

†We are indebted to Doctor Mahone, the resident genito-urinary surgeon for the painstaking manner in which the pyelograms were made in all of the cases.

TABLE VI

Injuries of Horseshoe Kidneys

Case No.	Author and reference	Description and remarks
1	Ehler: Wien. Kl. W., 59, 321, Feb. 6, 1909	Crushing injury of abdomen. Temponnade. Autopsy revealed tear of isthmus.
2	Brunner: Beitr. Klin. Chir., 122, 146, 1921	Heminephrectomy for rupture of one-half of horseshoe kidney.
3	Hinterstoisser: Wien. Klin. Woch., 33, 942, Oct., 1920	Crushing injury. Heminephrectomy. Death.
4	L. Herman: J.A.M.A., 83, 17, 1924, pp. 1315-1321	
5	S. C. Dean: ANNALS OF SURGERY, 75, 253, 1922	Gunshot wound of hilus of right half. Heminephrectomy. Recovery.

TABLE VII

Miscellaneous Cases

Case No.	Author and reference	Lesion and remarks
1	Moynihan: Brit. Med. Jour., 1, 263, Feb. 1, 1902	Aspirated and removed wall of cyst of isthmus.
2	Pichler: Mitt. a. d. Grenz., geb., 30, 557, 1918	Made diagnosis horseshoe kidney by palpation and confirmed at autopsy.
3	*Idem.*	Same.
4	*Idem.*	Same.
5	Gerster: Mt. Sinai Hosp. Rep., 1, 214, 1899	Decapsulation for acute nephritis. Recovery.
6	Kuttner: Berl. Klin. Woch., 30, 471, 1911	Exploratory for chronic hemorrhagic nephritis. Diagnosis before operation by palpation.
7	Sturmdorf: Rev. de Gyn. et Chir. abd., 3, 1053, 1903	Mobile horseshoe kidney. Nephropexy.
8	Buss: Zeit. Klin. Med., 38, 349, 1899	Nephrectomy (through error) of entire horseshoe kidney lying in true pelvis.

Both ureters entered the respective pelves in a peculiar manner, passing behind the shadows of the mesially directed calyces. From the above findings a diagnosis of horseshoe kidney was made and confirmed at operation. It was necessary to extend the usual lumbar kidney incision forwards so that the anterior surface of the renal pelvis could be exposed after displacement inwards of the peritoneum. The upper pole was at the level of the costal arch and one could follow an isthmus of about 4 cm. width inwards until it crossed the spine. Through an incision in the anterior aspect of the renal pelvis, much phosphatic detritus and two well-formed but soft calculi were removed. No attempt was made to close the pyelotomy incision. The convalescence was uneventful.

CASE II.—*Pyelotomy for renal calculus in one-half of horseshoe kidney. Presence of this anomaly diagnosed before operation.*

Male, aged fifty-one, with history of fistula following drainage of right perinephric abscess ten months before. There was marked pyuria and absence of dye excretion from this right kidney, but clear urine and prompt concentrated dye output on the left side. Radiography (Dr. Cora M. Matthews) revealed a series of four oval shadows (A of Fig. 15) on the left side and close to the spine. They were directed downwards and inwards, so that the lowermost one was in contact with the outer end of the left transverse process of the fourth lumbar vertebra. The intrarenal character of these shadows was confirmed by the relation of the opaque catheter and by pyelography (B of Fig. 15). The former curved sharply inwards and at its upper end was in close contact with the lowermost of the calculous shadows. The opaque medium included all of the shadows and revealed a narrow vertical pelvis, with the upper calyx directed mesially. From these findings alone a diagnosis of calculi in the left half of a horseshoe kidney was made. In order, however, to more accurately ascertain the condition of the right half, a pyelogram was made and revealed (C of Fig. 15) an advanced degree of dilatation of the renal pelvis, thus confirming our findings on ureteral catheterization. Before a right heminephrectomy could be considered it was deemed advisable to remove the calculi from the left half.

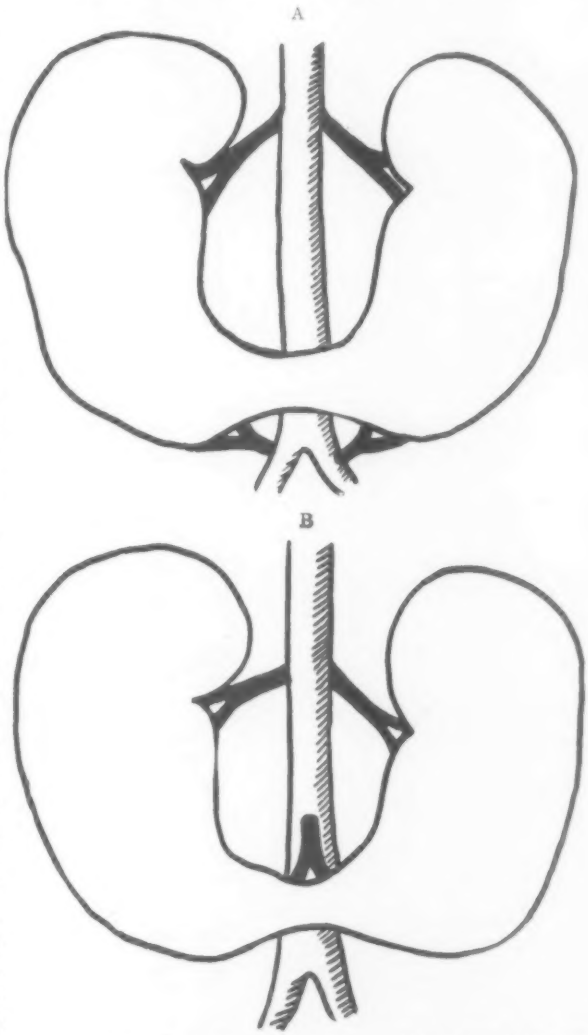

FIG. 13, A and B.—Most frequent types of blood-vessels (Papin). A. Single vessel to each half and two to isthmus. B. Single vessel to each half and one to isthmus.

On June 17, 1925, the left renal pelvis was exposed extraperitoneally, on its anterior aspect. The upper pole of this half of the horseshoe kidney was, as in the first case, at the level of the costal arch and the lower pole was continuous with an isthmus which measured 3 to 4 cm. in a vertical direction. The ureter, as in the first case, passed across the front of the isthmus and like the pelvis, showed marked thickening of its walls. No difficulty was experienced in the delivery of four calculi through an incision in the anterior aspect of the renal pelvis. The convalescence from this operation was uneventful

ful and an attempt will be made in the near future to remove the pyonephrotic right half. (C of Fig. 15.)

CASE III.—*Tuberculosis of one-half of a horseshoe kidney.* Presence of this anomaly diagnosed by pyelography but not yet confirmed at operation.

Male, aged twenty-four. Sudden onset of severe pain over right kidney region of one week's duration. Frequency of urination especially during the day for a longer period. There was considerable tenderness over the right kidney. One brother had kidney removed for tuberculosis. Bladder urine very turbid, as was also that from the left kidney. Dye excretion from this side was delayed and poor as compared with the opposite (right) side. Acid-fast bacilli were found by Doctor Connell, the interne in charge, in the bladder urine, but they could not be found in the urine from the left kidney. Radiography (Dr. Cora M. Matthews) revealed nothing abnormal in the plain film, *i.e.*, before the opaque catheters were passed. The film taken after these (opaque catheters) were introduced and the opaque median (12 per cent. sodium iodid) injected on both sides revealed the following very interesting findings. (Fig. 16.)

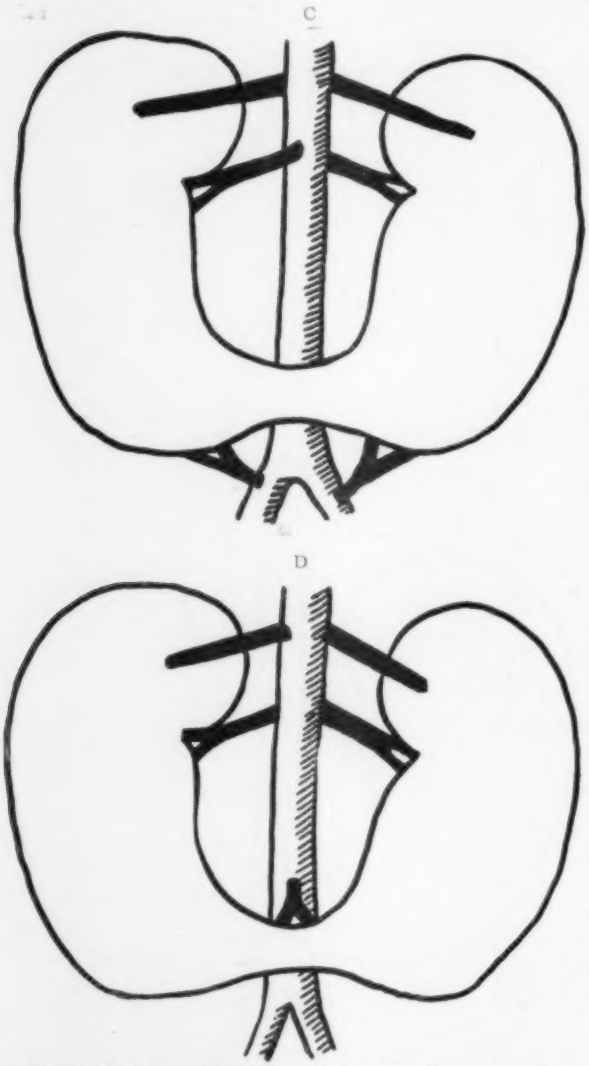

FIG. 13, C and D.—Most frequent types of blood-vessels (Papin). C. Two vessels to each half and two to isthmus. D. Two vessels to each half and one to isthmus.

1. The opaque catheters on both sides curve outwards as they reach the lower border of the fourth lumbar vertebra. This is more marked on the left side.

2. The right pyelogram has an unusual contour. At its upper end one observes superior and middle calyces which are approximately normal in location but unusual in arising from an expanded area of the pelvis instead of a tapering portion as is to be seen in the normal pelvis. There is a rudimentary inferior calyx directed laterally.

The most striking feature, however, of this right pyelogram is seen at its lower end. Here one notes the extension mesially of the pelvis proper, so that it completely covers the corresponding transverse process of the third lumbar vertebra. This portion of the pelvis is almost quadrilateral in form and has rudimentary calyces along its mesial and

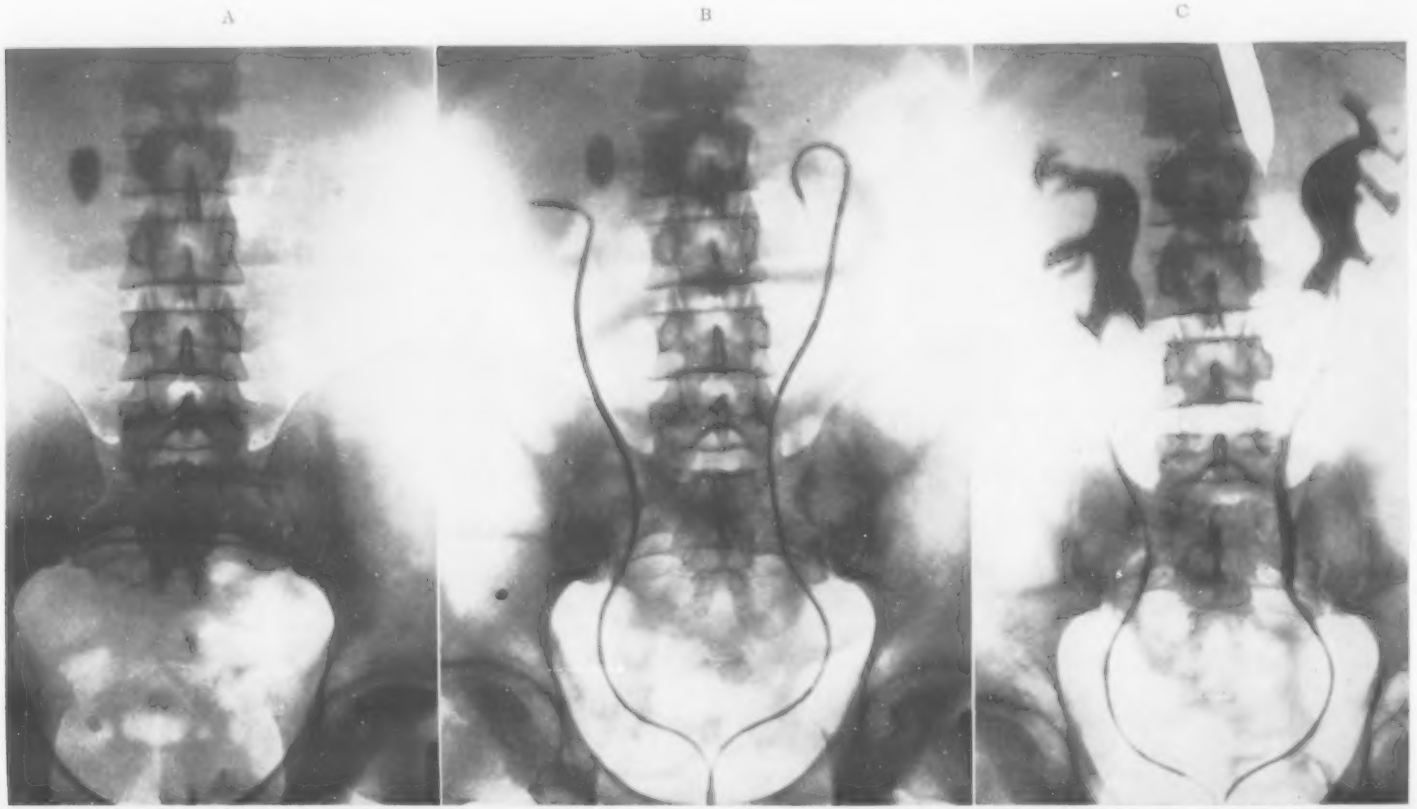

FIG. 14.—Radiographic and pyelographic findings in Case I. A print—Shadow of right renal calculus over outer end of right transverse process of second lumbar vertebra. B print—Note how right opaque catheter turns outward and left one inwards. C print—Note mesially directed calyces (see text) and unusual forms of both pyelograms; also close proximity of right one to spine.

FIG. 15.—Radiographic and pyelographic findings in Case II. A. Shadows of the four calculi arranged in serial manner obliquely opposite fourth lumbar vertebra. B. Pyelogram including shadows seen in A, with several calyces directed mesially. Note peculiar shape of this pelvis. C. Pyelogram of right half showing marked dilatation of pelvis and calyces (infected hydronephrosis).

caudal borders. A diagnosis of horseshoe kidney could be made from such a pyelogram alone.

3. The right ureter runs behind the inferior calyx and enters the pelvis along the middle of its curving caudal (inferior) border.

4. The left pyelogram also reveals some features which are characteristic of horse-

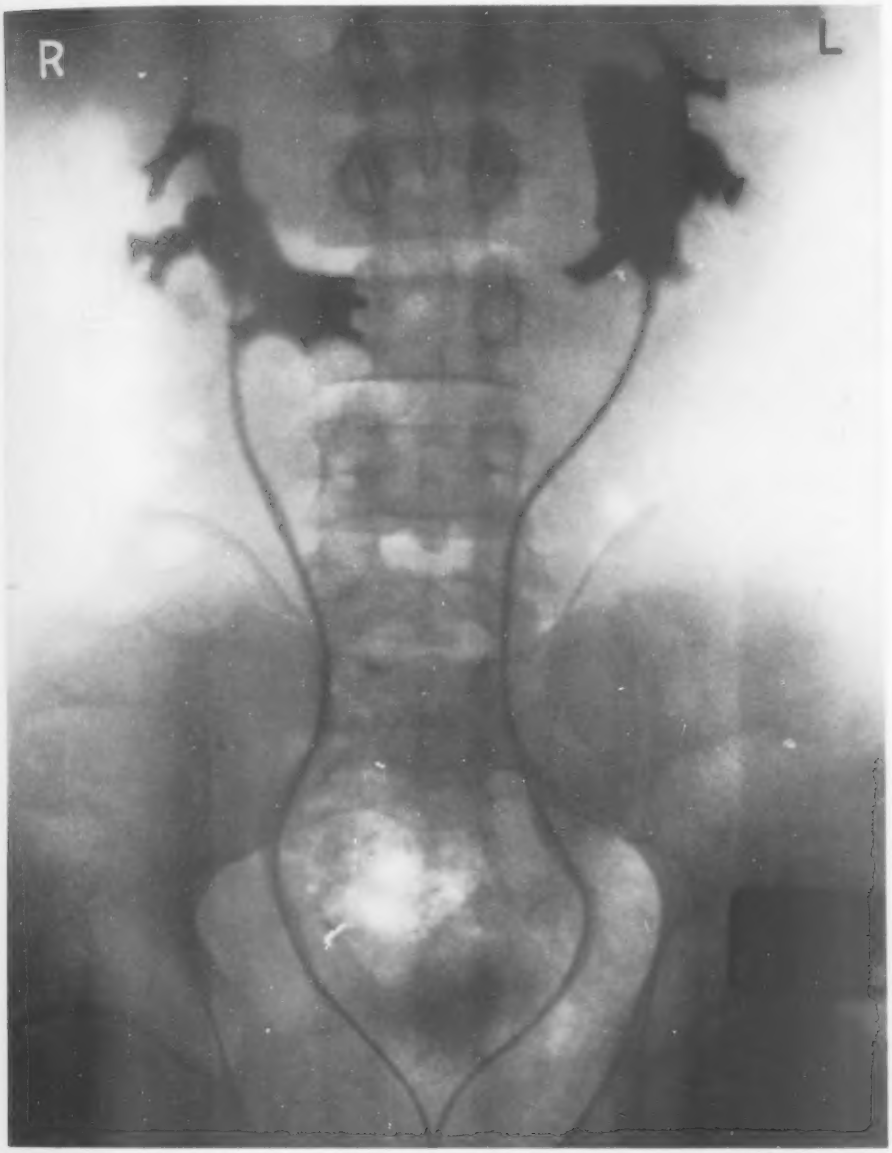

FIG. 16.—Pyelographic findings in Case III. Note mesially directed calyces on both sides; also how right pelvis extends across front of body of third lumbar vertebra. Note unusual form of both pelves.

shoe kidney, due to faulty rotation. The pyelogram is situated at about the distance from the spine which is found under normal conditions. The pelvis itself has a peculiar form, there being a marked protrusion along the mesial border at the upper inner angle. The superior middle and inferior major calyces are very short and the ureter as on the

right side runs behind the inferior major calyx to enter the pelvis along the middle of its caudal (inferior) border, instead of its mesial as in the normal kidney.

A more significant finding is that one of the calyces is directed mesially, an almost pathognomonic evidence of renal torsion, as Braasch has pointed out.

From our pyelographic evidence we feel confident that we are dealing with a tuberculosis of one-half of a horseshoe kidney, but the patient having thus far refused operation, we must postpone confirmation of our diagnosis for the present.

RÉSUMÉ OF ALL PUBLISHED CASES AND OUR OWN

1. Clinical Pictures.—Aside from the syndrome first described by Rovsing [14] there are no pathognomonic symptoms indicative of this anomaly.

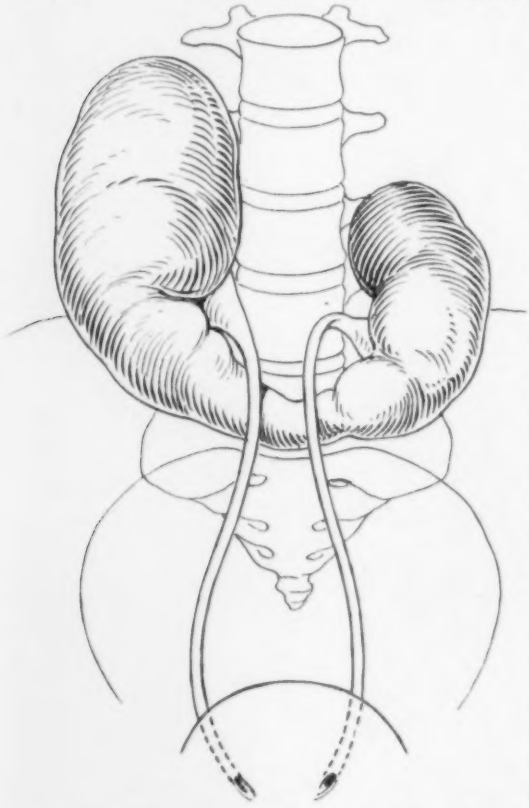

FIG. 17.—Hydronephrosis of right half of horseshoe kidney. (Bockenheimer.)

In the cases first reported by Rovsing and since by others (see Table I), the abdominal pains are thought to be due to pressure of the isthmus on the large vessels behind it (aorta and vena cava) and accompanying them. The complete relief of symptoms after division of the isthmus (symphysiotomy) lends support to this compression theory. The pain in these cases is referred to both lumbar regions and is vaguely localized in different parts of the abdomen. The most characteristic feature is the increased degree of pain on leaning forwards or upon exertion, and its complete disappearance on lying down. Neufville [15] described an unusual case related to this syndrome of Rovsing. A young man of twenty-five had œdema of both lower limbs and a slight degree of ascites for a brief period. At autopsy the vena cava was found thrombosed by the compression of a vena cava. We quote this case with skepticism as to the relation of the anomaly to the thrombosis.

In Table IX we have grouped the entire 132 cases, including our own, as to the frequency of the various lesions and would direct attention to the fact that the majority are the result of the conditions mentioned above as being present in horseshoe kidney and favoring stagnation. For this reason, diseases such as calculi, hydro- and pyonephrosis, etc., constitute the majority.

2. Diagnosis.—(Compare with Table VIII.) In the earlier cases, the proportions which were diagnosed by palpation alone is far greater than since the advent of radiography supplemented by pyelography. Of a total of 133 cases (including our first two) only 19, or 14.2 per cent., were diagnosed before operation or autopsy and confirmed. From the modern urologic standpoint we can eliminate the ten cases (all except Van Houten in the first

TABLE VIII[1]

Cases Diagnosed before Operation or Autopsy[2]

Palpation or plus pyelography	By proximity renal shadows to spine	By proximity calculus shadows to spine	By pyelography alone	Proximity calculus shadows to spine	Suspected before operation
Martinow, I–2	Zondek, III–28	Judd, Braasch and Scholl, III–19	Papin, I–1	Judd, Braasch and Scholl, III–21	Kroiss, I–9
Rovsing, I–3	Voorhoeve, III–19		Rathbun, II–39	Eisendrath, Phifer and Culver, III–24	Rovsing, I–13
Malinovsky, I–4				*idem*, III–25	Steiner, III–2
Van Houten (3) I–11					Israel, III–4
Israel, IV–3					
Pichler, (2), VII–2					
Pichler, (2), VII–3					
Pichler, (2), VII–4					
Newman, III–16					
Israel, II–49					
Kuttner, VII–6					
Totals 11	2	1	2	3	4

1. Figures after author's name refer to Table and Case number respectively.
2. Pichler's cases were not operated, but confirmed at autopsy.
3. In this case diagnosis made by palpation and confirmed by pyelography.

TABLE IX

Frequency of Various Lesions

Table No.	Pain	Hydronephrosis	Calculi	Tuberculosis	Pyonephrosis	Others
1	11		1			
2		23	13	13	6	9
3		1	34		1	
4		7	3			
5		2				
6						4
7		1				3
Totals	11	34	51	13	7	16

column of Table VIII) in which diagnosis was made by palpation alone because this would hardly be depended upon at the present time. One can also discard the four cases not included in the nineteen (Table VIII) in which the diagnosis was only suspected, thus leaving nine cases in which more recent methods of diagnosis ‡ were employed. From an analysis of these nine cases we can cite the following as important radiographic features.

‡ Radiography (plain) supplemented by employment of opaque catheter and pyelography.

(a) The close proximity of one or both renal shadows to the spine at a lower level than normal.

(b) The close proximity to (Fig. 14) or obliquity of position (Fig. 15) in relation to the spine, of the shadows of renal calculi. If one or both halves of the horseshoe kidney lie close to the spine the value of (a) and (b) as diag-

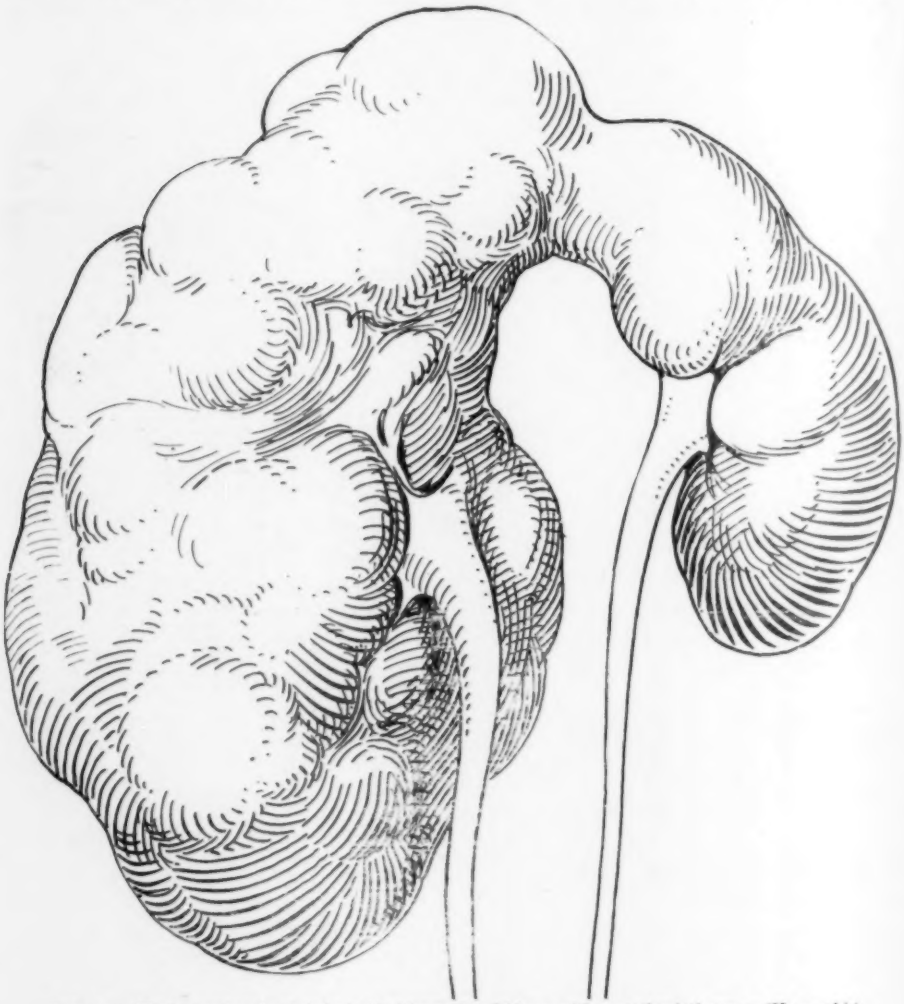

FIG. 18.—Hydronephrosis of right half of horseshoe kidney with superior isthmus. (Karewski.)

nostic features cannot be underestimated. If, however, one or both halves are symmetric (Fig. 1), *i.e.*, at the same level and as far away from the spine as is the normal kidney, the above data are of little value alone. One must also recall the possibility of renal or calculous shadows being at different levels (Fig. 2) in an asymmetric horseshoe kidney.

(c) Urography.—This in our opinion is the method which corroborates the suspicions raised by the findings cited under (a) and (b). If one or both pyelograms (Figs. 14, 15 and 16) lie in close proximity to the spine at

the same or different levels, or even extend partly across the spine (Fig. 6), as in one of our own and in Rathbun's case, there can be little doubt as to the presence of horseshoe kidney. The same is true even if one pyelogram is close to the spine and the opposite one at the normal distance. (Fig. 14.) If, however, both pyelograms are not close to the spine one must depend on other findings which are of great value not only under these conditions of normal distance of pyelograms from the spine, but also when one or both are in close proximity.

These additional data were first called to our attention by Braasch. They are due to the faulty rotation of the halves of a horseshoe kidney. As a result we find (a) one or more calyces directed mesially (Fig. 14); (b) very long, narrow pelves (Fig. 15) or "bizarre" shapes; (c) unusual course of the ureter, *i.e.*, passing behind a calyx (Fig. 14) and not entering the pelvis along its convex border. (Fig. 14.)

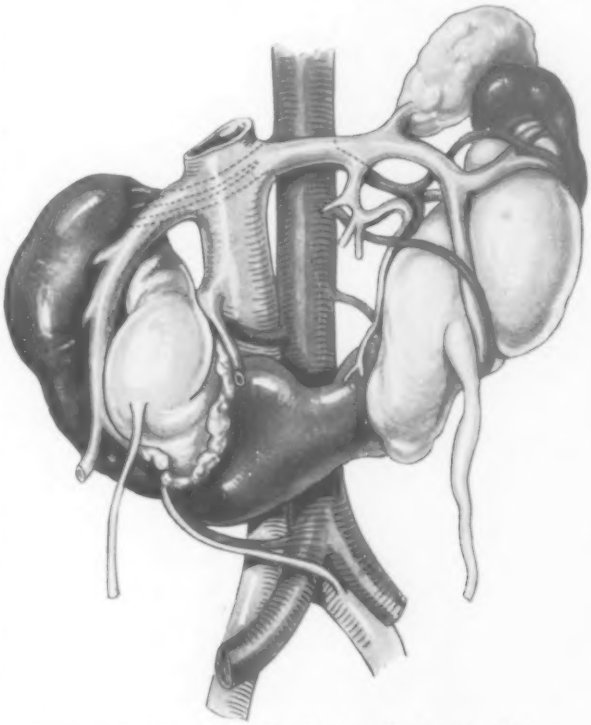

FIG. 19.—Hydronephrosis of both halves of a horseshoe kidney. (Papin.)

We believe that more widespread knowledge of these radiographic features will enable us to make a pre-operative diagnosis in the future in a larger percentage of cases.

TYPES OF OPERATIONS PERFORMED ¶

Table I.	Symphysiotomy (Division of isthmus), alone or combined with other operations, such as fixation of left half after pyelotomy for calculi (Egger's case)	12 cases
Table II.	Heminephrectomy alone	63 cases
Table III.	Pyelotomy or nephrotomy	35 cases
Table IV.	Primary pyelotomy or nephrotomy and secondary heminephrectomy	10 cases
Table V.	Plastics or ureterolysis	2 cases
Table VI.	Subparietal injuries	4 cases
Table VII.	Miscellaneous, not including three cases of Pichler (not operated)	5 cases
	Total	131 cases

¶ Owing to omission of mention of result of operation in a sufficiently large number to nullify the value of any deductions, the percentages of deaths and recoveries will be omitted.

Technic of Operations on Horseshoe Kidneys.—The method of approach should always be by the extraperitoneal route employing the same incision (lumbar) as in the normally placed and formed kidney. It is necessary, however, to extend the incision much nearer the outer border of the corresponding rectus muscle because access to the pelvis must be from the ventral and not from the dorsal aspect as in ordinary (posterior) pyelotomy. There is usually no difficulty in displacing the peritoneum while the patient is in the lateral position and then changing to a supine position while the pelvis and isthmus are being exposed. We found that this change of position of the patient after division of the various layers of the abdominal wall and strong retraction of the peritoneum enabled us to work under guidance of the eye in both cases. For heminephrectomy a similar good exposure is essential owing to the many accessory vessels (both arteries and veins) which enter the hilus, poles and isthmus in a very irregular manner. The isthmus can be clamped as one proceeds to divide it and the denuded areas closed by mattress sutures of chromic gut reinforced at loop and knot by fat pads.

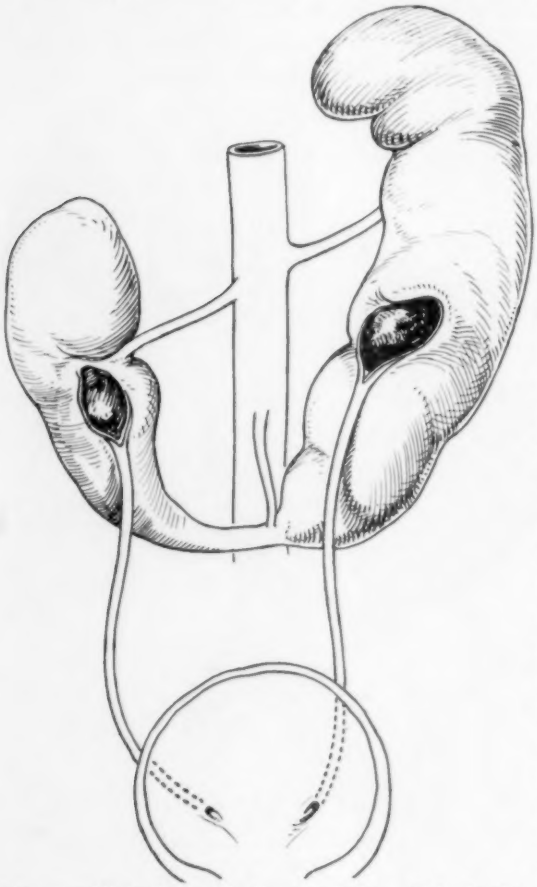

FIG. 20.—Bilateral calculi in horseshoe kidney. (Schuchardt.)

NON-PARASITIC CHYLURIA*

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of Los Angeles, Cal.

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Non-parasitic chyluria is of infrequent occurrence on the American continent. The literature is chiefly European, especially German, few American writers having called attention to this curious clinical occurrence. Very little is known of the true causes underlying non-parasitic chyluria, and therefore it is essential that all cases be recorded. The presence of such a case on the University of California Urological Service of the San Francisco Hospital prompts the following report:

G. D., colored, single, twenty-one years of age, entered the hospital with the complaint of "cloudy urine." The family history was irrelevant.

The patient was born in South Carolina where he lived until the age of twenty years. During the last year he has been in California. His occupation has been various —cook's helper, boot-black and farm hand. He had measles and mumps as a child; no history of other illnesses. He has had five attacks of gonorrhœa in as many years, the last being two months ago; acute epididymitis and right inguinal bubo one year ago. Primary denied. Habits good. No history of any accidents. Inguinal bubo drained one year ago.

The present illness began three years ago, at which time he noticed that the urine was milky in color. Since then it has been intermittent, bearing no relation to diet, work, etc. Two months ago patient thought that some blood was present in the urine. During the last two months there has been a dull lumbar pain, especially on the left side. The remainder of the history is irrelevant except that the patient was still being treated for his last venereal infection.

The physical examination showed a well developed and nourished negro, in no apparent distress. General examination was negative. Blood-pressure 120/80. *Genitalia*: Slight urethral discharge; smear negative for Gram-negative intracellular diplococci. Prostatic massage 10 per cent. pus; normal amount of lecithin; many motile sperm.

Laboratory Data.—Blood: Hæmoglobin 80 per cent.; red blood cells 4,670,000; white blood cells 8800; polymorphonuclears 71 per cent.; lymphocytes 27 per cent.; transitionals 1 per cent.; cosinophiles 1 per cent. Examination of blood during night and day revealed no filariæ.

Urine: (voided specimen): Clear, amber, specific gravity 1.016; sugar negative; albumin negative. Micro.—Red blood cells rare; white blood cells rare; casts, none; epith. rare. Examination negative for filarial parasites.

Blood Wassermann: Negative.

Phthalein (intramuscular): 1st hour, 50 per cent.; 2nd hour 25 per cent.; total 75 per cent.

X-ray: Kidneys, ureters and bladder essentially negative.

Cystoscopic Examination.—Cystoscope F 26 easily inserted. No residual urine Bladder capacity—350 c.c. Bladder wall showed mild diffuse cystitis, otherwise negative for stone, tumor, ulcer, etc. Left ureteral orifice reddened and œdematous. Right orifice negative. Trigone markedly reddened and revealing some bullous œdema, espec-

* Read in brief before the California Medical Association, May 18, 1925.

ially on the lower half and extending on to the vesical neck. Both ureters easily catheterized to kidneys. The left ureteral catheter immediately began to drain milky fluid with a pinkish tinge. The bladder urine had been clear.

	Right	Left	Transvesical
Size of catheter	F 6	F 6	
Flow	Normal	Normal	
Macroscopic	Clear	Milky	Clear
R. B. C.	Numerous	Numerous	None
W. B. C.	None	2–3 h. d. f.	2–3 h. d. f.
Epith	1–2 h. d. f.	2–3 h. d. f.	2–3 h. d. f.
Casts	None	None	None
Organisms	None seen	None seen	None seen

Phthalein (intravenous):

Appearance time	2 minutes	2½ minutes
1st 15 minutes	20%	17%
2nd 15 minutes	10%	4%
Total	30%	21%

Bladder leakage—none.

Cultures.—B. coli in left kidney and bladder specimens. Right kidney sterile. All acid-fast stains negative.

The urine from the left kidney could not be centrifuged clear and microscopically showed no morphology except an occasional pus cell and many cell blood cells. The specimen was immediately suspected as being that of a chyluria. The milky color cleared almost entirely upon shaking with ether; the residue of an evaporated ether extract stained readily with Sudan III. Upon standing, a rather firm, pinkish clot would form in the urine. This urine was positive for albumin, while the clear specimens had been negative. No parasites were found.

A pyelogram of the left kidney appeared normal except for a slight haziness about the upper calyx. (Fig. 1.) Right pyelogram was negative. The lumbar backache was not reproduced with either pyelogram.

Course.—With the finding of no parasites in either the blood or the urine, the case was considered as a chyluria, non-parasitic in type, and left renal in origin. No significance was placed in the slight finding of the upper left calyx as shown in the pyelogram. The urine continued to be intermittently cloudy, occurring four to five times weekly and usually in the morning. The presence or absence of fat in the diet did not seem to influence its occurrence.

The patient received three pelvic lavages of the left kidney within a period of fourteen days, using each time 3 c.c. of 1 per cent. silver nitrate. The chyluria disappeared after the third lavage. This was followed by a rise in temperature to 100° F., which subsided in four days. During this time the patient continued to have a dull, non-radiating pain in the left flank. Two days later the temperature again rose, reaching a peak of 103° F. on the third day. Cystoscopy with catheterization of the left kidney revealed nothing; however, examination of the chest gave sufficient evidence to make a diagnosis of mild bronchopneumonia. This cleared up entirely in eight days. The temperature continued more or less normal, but the slight dull pain in the left flank persisted. The urine was clear at all times. Examination by careful palpation now revealed some spasticity of the lumbar muscles and a vague feeling of a mass.

A complete urological examination was again performed. The left pyelogram on first injection now showed a cavity 1½ x 3 cm. in size irregular in outline and lying out under the eleventh rib. (Fig. 2.) Further injection with the ureteral catheter pulled down demonstrated the left kidney pelvis and ureter, the lower calyces being normal, while the upper ones appeared somewhat deformed by pressure from without. It was

therefore concluded that there was present a large perirenal abscess at the upper pole which might communicate through the upper major calyx. (Fig. 2.)

Operation revealed the following: The lumbar muscles and fascias were very dense and fibrotic. A large abscess cavity was opened into and about 150–200 c.c. of dark brown pus and necrotic material evacuated. This had been preceded by a gush of about 50 c.c. of urine-like fluid. Culture of the abscess gave B. coli. Examination of the abscess cavity showed it to be the size of one's fist, intimately associated with the upper and middle parts of the kidney and extending anteriorly to the peritoneum. The abscess was found to communicate with the kidney through a small sinus-like aperture on the posterior aspect of the upper pole. Further examination could not be carried out because of the dense inflammatory adhesions everywhere. No definite cause could be established for the chyluria. An intracapsular nephrectomy was performed, the cavity thoroughly irrigated with 1–1000 mercurochrome, and the usual closure with drainage made. Uneventful convalescence, the wound healing by primary union, except posteriorly where drainage had been instituted. The patient, seen two months after the operation, was in good health and the urine was clear.

FIG. 1.—Pyelogram of left kidney six weeks prior to operation. There is a slight haziness about the upper calyx.

Gross Pathology.—The specimen consists of a kidney measuring 8 x 6 x 3½ cm. The external surface has adherent large masses of blood and necrotic tissue. The surface of the kidney is dull with flakes of fibrin attached. No capsule can be found. The cut surface shows fairly normal appearance, except that in the vicinity of the sinus above mentioned the tissue is dull and compact. Just below the convex border and on the posterior aspect is a small sinus communicating with the posterior minor calyx of the upper major calyx. Sinus blocked with necrotic tissue. (Fig. 3.)

Microscopic Pathology.—Microscopic sections show numerous glomeruli, varying in size from large to small. The latter are atrophic in appearance. Bowman's capsule has disappeared in some places, so that the glomerulus can hardly be seen. The tubules are often dilated. Cloudy swelling is marked in most areas. There is a very diffuse moderate lymphoid cell infiltration.

An irregular cavity is seen in one section. It has a ragged lining of connective tissue, heavily infiltrated with lymphocytes; plasma cells, endothelial cells laden with blood pigment and occasional eosinophiles. (This section was taken through the sinus connecting with the abscess.)

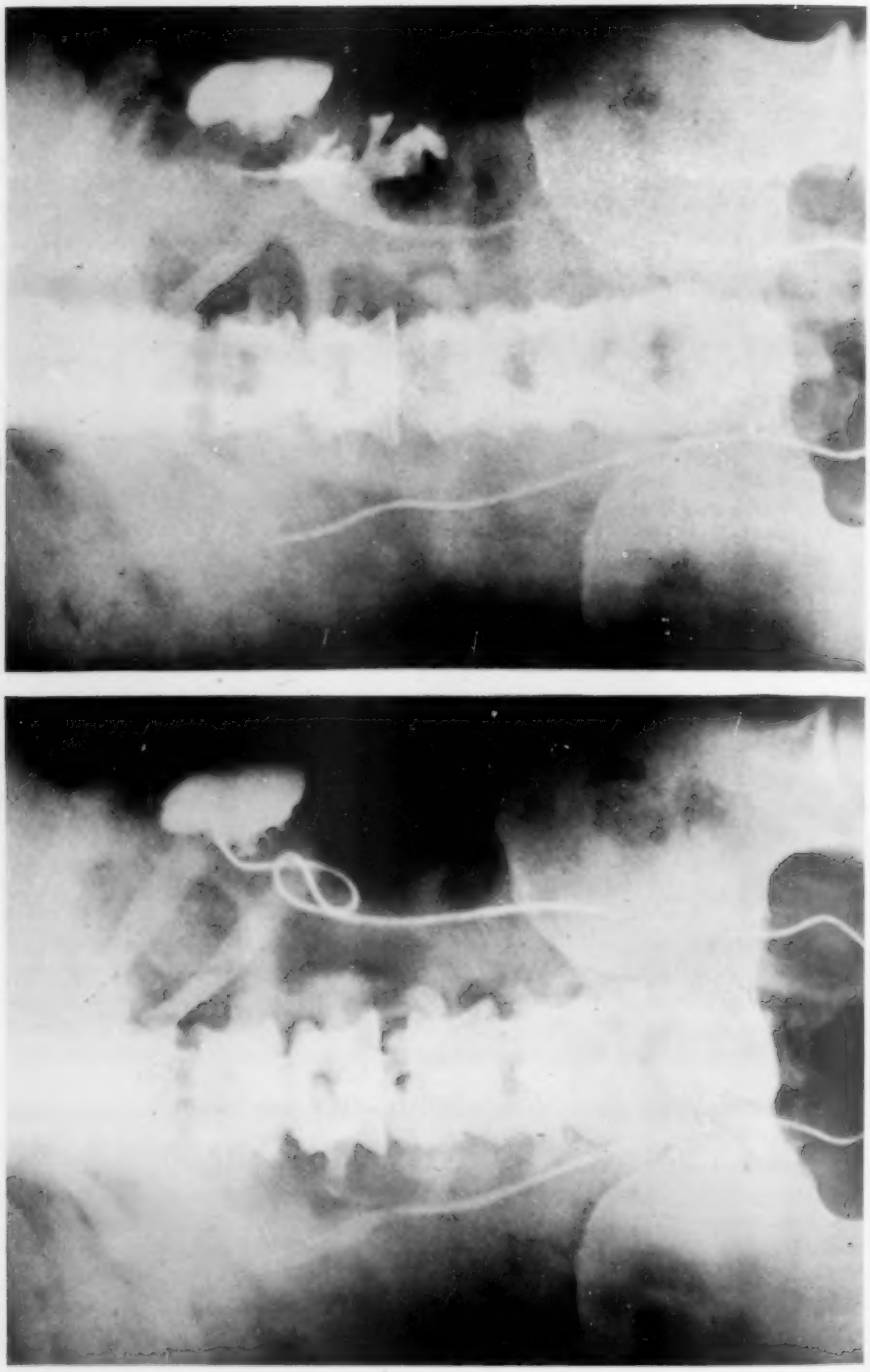

FIG. 2.—Pyelograms of left kidney just before operation. The first shows the perirenal abscess injected; the second pyelogram was taken immediately afterward with the ureteral catheter drawn down. Note the relation of the abscess to the kidney pelvis and the deformity produced in the upper calyces.

A layer of connective tissue, moderately infiltrated with mononuclear cells lies external to the cortex and is the abscess wall. (Figs. 4 and 5.)

Diagnosis.—Perinephritic abscess with chronic diffuse nephritis. Communicating sinus between abscess and kidney pelvis.

The case was considered as being one of non-parasitic chyluria because of the characteristics presented by the urine and the absence of parasites. The duration was over a period of three years and yet the patient was not incapacitated in any way. The co-existence of the perinephritic abscess and its communication with the kidney pelvis probably had no relation to this patient's chyluria. It is not likely that the abscess had been present for three years and yet not given rise to more symptoms. The history of lumbar pain over a period of two months probably indicates the existence of the abscess.

FIG. 3.—Photograph of left kidney in longitudinal section. The stick (A) marks the path of the communicating sinus between the perirenal abscess and the upper calyx of the kidney pelvis. The tissue attached to the upper pole is part of the abscess wall and kidney capsule.

Detailed fat studies were not carried out because of the lack of facilities. The case presents many similarities to others reported in the literature, namely, periodicity as to occurrence intermittently and time of day. Various authors have found that chyluria was present in the night or morning urines and cleared as the patient became more active during the day. The various characteristics, such as the pinkish milky color, absence of morphological characteristics microscopically except for red and white blood cells, failure to centrifuge clear, even at a high rate of speed, clearing with ether, prove this to be a case of chyluria. The failure to find filariæ in the blood and urine, places it in the non-parasitic group.

Historical Note and Discussion.—The recognition of fat in its various forms as occurring in the urine is no new one. The mention of fatty and oily urines has been found in the ancient writings of Hippocrates, Galen and Theophile (Sanes and Kahn). Its significance was variously interpreted as approaching delirium, convulsions, death or the excretion of milk in the

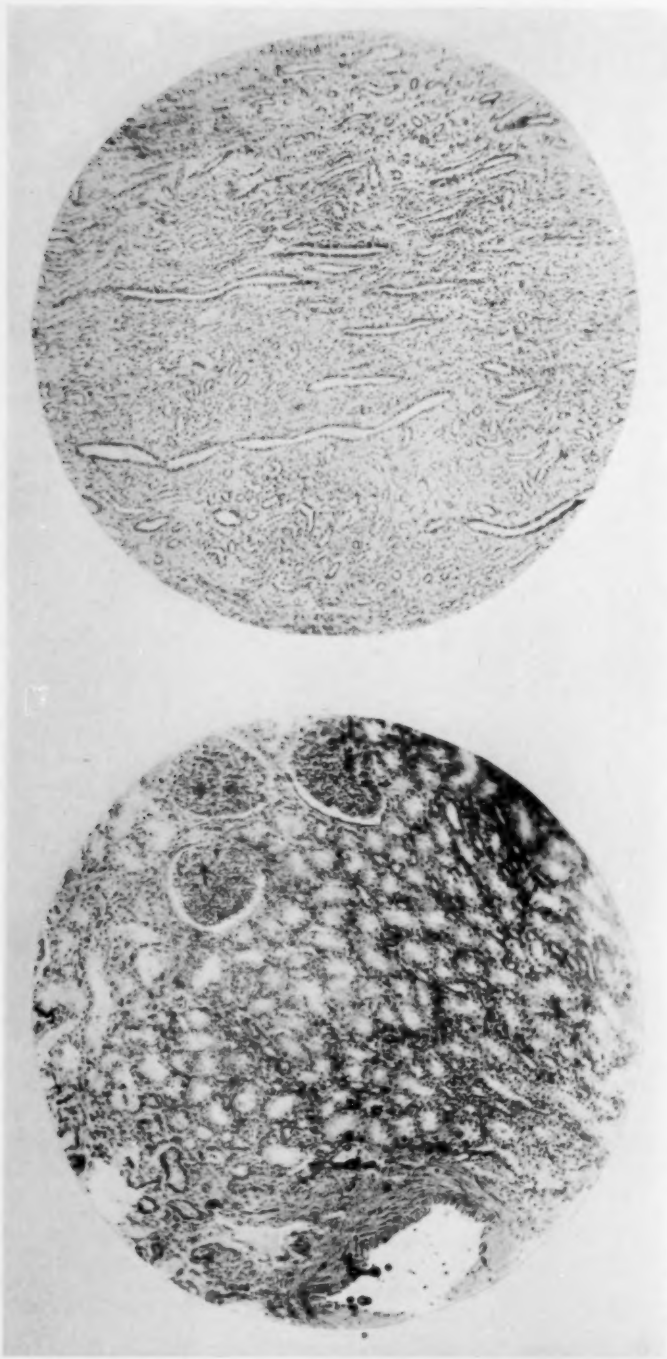

FIG. 4.—Photomicrographs (low power) showing some cloudy swelling of the convoluted tubules and sclerosis of the blood-vessel walls. In the medullary part of the parenchyma there appears to be some dilatation and decrease of the collecting tubules with a corresponding increase of œdematous interstitial tissue.

urine. The writers of the middle ages added but very little. Actuarius (thirteenth and fourteenth centuries), Gordon (fourteenth century) and others ascribed it as a symptom of hectic fever, phthisis and a very grave indication of impending death. In 1670, Moellenbroccius designated the condition as chyle in the urine and called it "mictio chylosa." This trend nearer to the truth had probably been brought about by the discovery of the lymph circulation by Pecquet in 1651. Stalpart van der Wiel (1687) wrote an extensive treatise at this time, citing Florentinus, who mentions probably the first case occurring in a child (thirteen-year-old boy). He concluded that the substance was chyle and based his theory on the bladder lymphatics described by Bartholinus and that the milky urine was due to a compression of the bladder channels (vasa lactea). Peu in 1694 found a chyluria occurring in a parturient woman and ascribed it as a means of eliminating excessive milk fat. Morgagni in his discussion felt it to be of renal origin. There followed but few studies, those of Stöller (1777), J. P. Frank (1794) and Vogel (1807). Stöller was the first to use the terms, "diabetes lacteus," "chylarius" and "cœliacus urinalis" and differentiated them from phosphaturia and pyuria. Frank's case was that of a chylous diabetes. Alibert and Cabelle (1817) designated the condition as "urine laiteuse." Many excellent studies and observations followed—Prout (1835), Rayer (1838), Golding-Bird (1843), Bramwell (1858), Beale (1861), Bence-Jones (1862), Roberts (1872), Oehme (1874—first autopsy in a non-parasitic case), Goetze (1877), Glazier (1877), Haddon (1879), Vogelius (1879—associated with pernicious anæmia), Brieger (1880), Concatto and Guareschi (1881) and many others. Probably the best studies of non-parasitic chyluria have been those of Senator (1883 and 1894), Franz and Stejskall (1903) and Magnus-Levy (1908).

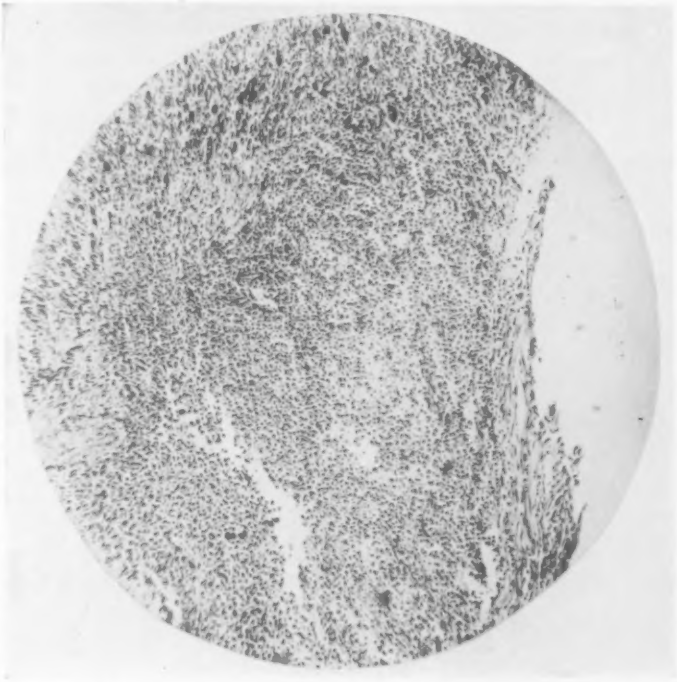

FIG. 5.—Photomicrograph (low power) through wall of communicating sinus showing marked fibrosis and round cell infiltration.

Goebel (1921) has written a good discourse of its rare occurrence in children. These do not include the host of workers on the parasitic chyluria; in these, Wücherer (1869), the first to demonstrate filaria in parasitic chyluria; Manson, discoverer of the filarial parasite; Mackenzie, Carter, Waters, Low and many others are worthy of mention. From time to time lengthy discussions have appeared as to etiology of non-parasitic chyluria, but they differ very little to-day from those of the earlier writers.

Etiology.—Chyluria may be divided into two types: (1) Parasitic or tropical group, (2) non-parasitic or non-tropical group. A third group, called functional chyluria (Sanes and Kahn, Marion) can well be placed in the second group. In the parasitic type the filaria sanguinis hominis is the chief causative agent, although chyluria has been mentioned with tænia nana (Predtetschensky), eustrongylus gigas (Stuertz), cercomonas hominis (Rosenheck and Rodhenburg), malaria (Quarelli), etc. Wücherer, in 1869, showed the filaria to be present in patients with parasitic chyluria (Welfeld). It is, however, the mechanism that has given difficulty. In the non-parasitary chyluria, both the etiologic and mechanical factors are upon a theoretical basis.

Since the discovery of the lymph circulation by Pecquet in 1651, the mechanism and point of entry into the urinary tract has been sought for. Prout and Rayer brought forth the theory that chylous urine was separated from the blood and that there were no abnormal communications between the lymph system and the urinary tract. To support this, they assumed a chylous blood condition—"chylöse blutbeschaffenheit"—with a lowered threshold of substance exchange and thereby leading to a pathological filtering through the kidney. This theory later found supporters in Eggel, Thudichum, Brieger, Virchow, Goetze, Cohnheim, Wolff, Waldvogel und Bickel. This theory has gradually lost ground until it has very few if any adherents.

The second and more feasible theory has been that of lymphatic obstruction and abnormal communication with the urinary tract for the chyle to enter. This was first brought forth by Carter in 1862, reporting two cases of filariasis with lymph scrotum. It was assumed that the filaria obstructed the lymph flow, caused inflammatory changes and ruptured into the urinary tract. Tropical chyluria has lent itself well to explanation on this basis. The work of Mackenzie and the substantiating evidence by Manson have given strength to this theory. Numerous workers—Dickinson, Havelburg, Siegmund, Myers, Grimm, Vieillard, Feuerstein and Panek, Slosse, Prebtetschensky, Magnus-Levy, Port and others—have adhered to this theory. It is the one most universally used at present to explain chyluria. We, therefore, have to assume an anatomical lesion of the lymphatics (Carter) rather than a constitutional anomaly (chylöse blutbeschaffenheit). Evidence, much of it questionable, has been offered from time to time to strengthen the theory and to determine the point of entry into the urinary tract. Cases of non-parasitic chyluria have come to autopsy and revealed no information (Oehme, Roberts and Hertz). Port's case showed large caseous mediastinal glands obstructing

the thoracic duct, but no point of entry into the urinary tract. Havelburg at autopsy found a large multilocular dilated lymph sac extending from the left kidney to the bladder, where its attachment was sieve-like and thereby allowed the chyle to pass through. Ponfick's case was similar, but there was some skepticism about such portal of entry (Virchow). Lüdke thought his case to have a point of entry in the bladder. To further substantiate that chyluria is due to blockage in the lymph system, Magnus-Levy cited an eleven-year-old girl who had a swelling on the left hip which later led to the exuding of chyle. Fifteen years later a chyluria resulted and the chyle fistula disappeared.

Pope demonstrated by cystoscopy a chyle sinus on the bladder trigone. In connection with this, the case of Bloch is of significance. A girl seventeen years old had chyluria, especially in the morning, of several years' duration. Cystoscopy revealed a white dome-like structure just above the right ureter. On the medial aspect was seen a small opening from which came forth a strong stream of chyle. The cyst was destroyed and thoroughly cauterized. The chyluria ceased immediately. The patient was followed for a period of days and the urine remained clear. Cystoscopy has been a great aid in location of the chyluric source. Cases are reported as either being unilateral or bilateral or vesical in origin.

The route between the intestinal and renal lymphatics has been of much speculation. According to Magnus-Levy, the chyle must first go from the mesenteric lymph channels through the mesenteric lymph glands to the thoracic duct. Thence, because of obstruction, there is a retrograde flow to the upper lumbar lymph-glands which drain the renal lymphatics. To obtain such a retrograde flow, an insufficiency of the valvular system of the lymphatic channels must be assumed. Hampton has likened the renal lymphatics to the cerebral arterial vessels as points of lowered resistance. Assuming a lymphatic block in that system there may then occur a leakage of chyle through the kidney just as a cerebral hemorrhage due to hypertension. These points are all hypothetical. Possibly with a bettering of pathologic studies in the future, these points may well be proven and demonstrated. According to the researches of Stahr and Kumita, the lymph channels of the fibrous and fatty capsules, communicating with the lymph channels in the renal cortex, can be injected from the capillary bed of the muscularis of the small intestine (Quincke).

Goebel states that to have a chyluria, two conditions must be fulfilled: (1) The lymph channels must open into the urinary tract, and (2) the lymph channels through recurrent channels must empty their contents into these lymph channels of the urinary tract. Where only the first condition is fulfilled, there ensues a "lymphuria without chyle" and where both conditions are fulfilled, chyluria results. He further adds that it is known that there are connections between the lymph channels of the adventitia and muscularis of the ureter and bladder with the lymph channels of the intestinal mucosa and at the other end with the hypogastric and lumbar lymph channels. If, therefore, an opening occurs between the lymph channels of the mucosa and

the lumen of the urinary tract, a "lymphuria" occurs; recognized by the albumin content of the urine. Furthermore there must not be a continuous stream of lymph through the existing communication, but it must occur only under particular pressure relationships over the threshold for that particular channel. This threshold pressure relationship is likened to the lymphatics of the leg which are under increased pressure when the muscles are contracted as on standing or walking.

Marion's theory is somewhat more comprehensive. He has assumed that there are two types of non-parasitic chyluria; (1) secretory and (2) excretory. In the first type he cites the experimental work of Loeper and Ficai, who produced a lipuria by injecting mono-butyrine into the blood of rabbits. In the second type a fistulous communication is assumed, allowing the chyle to enter the urinary tract, due to traumatic rupture of the lymphatics or tumors, chronic inflammatory changes, etc., causing a lymphatic obstruction.

The influence of diet on non-parasitic chyluria seems pronounced in some case reports. Lüdke was able to cause a disappearance of the chyluria by fasting. Tezner, Welfeld and others have been able to substantiate this to some extent.

Nearly all of the theories are insufficient and little better than those promulgated a half century ago. Such questions as unilateral chyluria with thoracic duct block, the rarity of chyluria and yet the frequency with which large abdominal and thoracic tumors occur are a few of the points in need for further explanation. The theory of lymphatic block and direct urinary tract communication is probably the most sufficient for the present.

CLINICAL DISCUSSION

Occurrence.—Non-parasitic chyluria is rare, especially on the American continent. The greatest number of cases are those of European observers, who have called the condition "European chyluria" to distinguish it from the parasitic or tropical variety. This designation is a misnomer, the condition having been described elsewhere than in Europe. Goebel, in 1921, was able to collect 73 reported cases. These occurred chiefly in Europeans who had never resided in tropical countries. A review of the literature has brought the number well over one hundred. The occurrence in children is even more infrequent, but 12 cases having been reported. The occurrence of parasitic or filarial chyluria is more common, having been found in as high as 2 per cent. of inhabitants in some regions (Magnus-Levy).

Clinical Picture.—Non-parasitic chyluria occurs chiefly during early and middle adult life, although it may be found at all ages. Brandenburg's case was a seventeen months' old female baby, while Whelan's, Frank's and Rayer's cases were sixty-seven years, seventy years and seventy-eight years, respectively.

The milky or turbid appearance of the urine is usually the only presenting symptom with a sudden onset. An accompanying backache or renal colic may be the chief complicating complaint. This is considered as being due

to the fibrin clots occurring in the chyliform urine and moving down the ureter.

Chyluria has presented some interesting features as to time and duration. It may be either continuous or intermittent. In Osterode's case it was intermittent for five years, occurring but several weeks each year, before becoming continuous. The relationship to time of day has been peculiar. Some observers have noted it to be present at all times; many have observed it in only the night urines, it clearing as the patient became active during the day (Oehme, Haddon, Goetze, Franz and Stejskall); still others noted chyle in the day urine only (Berri, Bence-Jones, etc.). Concatto found it only when his patient was in motion. Because of these various relationships to posture, a comparison to orthostatic albuminuria has been made. However, in this respect it differs from albuminuria since it usually occurs while the patient is lying down.

The urine has been the subject of much study. Magnus-Levy in a right kidney specimen found it fractionally to be 35 per cent. urine and 65 per cent. chyle. The fat content, using the Babcock method, has been estimated from 1 per cent. to 3 per cent. Welfeld's first case contained 4.2 per cent. The albumin content may also be high, varying from 3 per cent. to 3½ per cent. Other substances found in these urines have been lecithin, cholesterin, fibrinogen and soaps. Grossly the color of chylous urine varies from a cream or yellowish color to white. It may be tinged slightly red due to the presence of blood. Microscopically, the presence of occasional white blood-cells and red blood-cells can be demonstrated. The fat is in molecular form and therefore presents no morphology. The specific gravity is slightly less than normal. Since chyle is alkaline in reaction, some observers have shown chylous urine to be less acid than normally.

Diagnosis rests chiefly on a careful history and thorough urinary studies. Places of residence must be ascertained. The urine is to be differentiated from lipuria and marked pyuria. In the former the fat is present in the droplet form, although occasionally emulsified to the extent of a milky color. In such cases the presence or absence of fibrinogen, cholesterol or lecithin will be of significance. Lipuria is usually found associated with fractures, eclampsia, intoxication due to phosphorus, arsenic and carbon monoxide, diabetes, fatty degeneration in abscesses and degenerative renal processes. Usually in such conditions, the fat is found in the urine in large drops or after cooling, as tallow-like masses. It is brought through the blood stream (lipæmia) or may originate through the fatty degeneration of the renal constituents. Chronic nephritis with lipoid degeneration is a classical example (Ridder). The elimination of fat is not always pathologic. The researches of Sakaguchi upon himself and others have shown that there normally occurs 0.0085 of a gram in the urine per twenty-four hours. The presence of a greater amount than this figure, either macroscopic or microscopic, should be considered pathologic and the underlying cause sought for. Microscopic examination will differentiate the severe pyurias. Careful blood and urine examinations for

parasites should be performed. The history of residence in a tropical country though no parasites be found, should always make the observer suspicious of a parasitic chyluria. Manson has shown that filarial infections tend to disappear in later life, yet the changes made in the lymphatics may be productive of a chyluria.

Chyluria has on rare occasions been found associated with other diseases. Diabetes mellitus and chyluria have been noted by various observers (Stöller, Frank, Vogel, Magnus-Levy, Sanes and Kahn, Brandenburg). Pregnancy and chyluria, as well as chyluria post-partum, have also been found associated (Golding-Bird, Berri, Concatto, Varaldo, Davis, Veis, Bugbee). Mohr's case occurred in a four-year-old child with pharyngeal diphtheria. Trauma has also been mentioned (Whelan, Ciauri). Keersmæcker's case is doubtful; an eight-year-old girl cleared of her chyluria following dilatations for enuresis. Tuberculosis of the peritoneum and carcinoma in the region of the kidney have also been named (Le Dantec), as well as pernicious anæmia (Vogelius).

Non-parasitic chyluria is usually a disease of long duration and because of its benignity has a fair prognosis. Rayer's case in a seventy-eight-year old woman was of fifty-five years' duration. Vieillard's case was twenty years, while Koopman's nineteen-year-old patient had had the condition since early childhood. Welfeld reported his case of fourteen years' duration. Very often the condition clears spontaneously while in others the loss of chyle leads to severe debility and finally death from exhaustion. The nature of the obstruction is of importance, since in case of malignancy the prognosis is poor. The nature of the associated conditions is also of importance.

The treatment has been one of great variation and diversity as would result in a disease so little understood as non-parasitic chyluria; hence it is chiefly symptomatic. The patient should be put on a low fat diet. Lavages of the kidney pelvis with weak silver nitrate solution (1 per cent. to 3 per cent.) may be used. Lower and Belcher cleared their case with neoarsphenamine. Should a patient progress poorly, renal exploration or even nephrectomy may be performed. The presence of any associated or complicating condition should also be treated. Fulguration or cauterization should be used where the point of communication can be demonstrated as in Bloch's case.

In the parasitic or filarial cases some success in treatment has been achieved in recent years. Deschamps using neoarsphenamine and Chabanier and Lobo-Onell with arsenobenzol reported successful treatment. Diamantis cured his case, using antimony and sodium tartrate intravenously.

The use of sodium citrate has been found commendable in those cases suffering with renal colic due to the clotting of the chylous urine.

SUMMARY

1. A case of unilateral non-parasitic chyluria, associated with a perirenal abscess is reported.

2. Non-parasitic chyluria is of rare occurrence, especially on the American continent.

3. Its etiology is still on an hypothetical basis, the most probable being that of lymphatic obstruction with an abnormal communication between the lymph channels and the urinary tract.

4. The symptomatology is characterized by the sudden onset, the milky urine, its periodicity and chronicity.

5. Diagnosis depends chiefly on a careful history as to residence, urinary studies, and the failure to find parasites in the blood and urine on repeated examination. Non-parasitic chyluria is to be differentiated from lipuria and severe pyurias.

6. Non-parasitic chyluria has been found associated with diabetes mellitus, pregnancy, pharyngeal diphtheria, trauma, pernicious anæmia, tuberculosis of the peritoneum, as well as large growths in the region of the kidneys and the mediastinum.

7. The prognosis in non-parasitic chyluria is usually good.

8. Treatment is empirical. The intravenous use of neoarsphenamine and pelvic lavages with 1 per cent. to 3 per cent. silver nitrate have given encouraging results. Kidney exploration and nephrectomy have been done in the poorly progressing cases.

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THE MECHANISM OF ACUTE OSTEOMYELITIS

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The present discussion includes only those cases of osteomyelitis caused by the ordinary forms of pyogenic bacteria, staphylococci, streptococci, etc. Cases due to infection with bacillus typhosus have a similar mechanism and biology and are included in this discussion. Cases due to infection by tubercle bacilli, syphilitic virus or actinomyces are not included; nor any case originating in such obscure pathology as that associated with thrombo-angiitis obliterans, senile vascular gangrene, Volkmann's contracture, etc., nor with the forms of gangrene associated with diabetes mellitus.

The old terminology used in association with the phenomena of bacterial infection and including such terms as sepsis, septicæmia, sapræmia, pyæmia, etc., will not be employed in this communication. The reasons for this were described in another communication and a simplified terminology was suggested. In this communication only the following terms—infection, bacteriæmia and general blood infection—will be employed with the following definitions:

1. The term "infection" will be used as a generic one and will include all of the phenomena of a bacterial attack on tissue, organ or the entire body. The various kinds of infection will naturally be described in accordance with the tissues, organ, or part of the body involved, and in accordance with the organism, or organisms encountered; thus saprophytic infection of the uterus, staphylococcus infection of the skin, or streptococcus infection of the liver, etc. When no other modifying term is employed it is to be assumed that cultivations of the peripheral blood taken during life are sterile. The differentiation commonly made between local and general infection theoretically does not exist and the terminology is one more of convenience than of accuracy. Local infections must necessarily involve some degree of general constitutional reaction and general infections must necessarily find their beginnings in, or be associated with a local focus of infection. As far as possible this differentiation will be avoided or made clear in the text whenever it must be used.

2. The term "bacteriæmia" will, also, be used in a generic sense to indicate any condition in which bacteria can be cultivated from the peripheral blood during life. The various kinds of bacteriæmia will, also, naturally be described in accordance with the organism found; thus staphylococcus bacteriæmia, streptococcus bacteriæmia, etc.

3. The term "general blood infection" will indicate a subgroup of the generic term "bacteriæmia" and in this communication a distinction will be made between the terms "bacteriæmia" and "general blood infection" on the following basis. The term bacteriæmia is meant to imply a condition in which the organisms demonstrable in the circulating blood by the usual cultural methods are derived from a local lesion somewhere in the body, are usually small in number and the faculty of destroying the circulating bacteria is more or less retained by the appropriate antibodies of the blood. The term "general blood infection" is meant to imply a condition in which in addition to the foregoing, a multiplication of the bacteria takes place in the circulation and the faculty of destroying the circulating bacteria is more or less lost by the appropriate antibodies of the blood.

Under appropriate circumstances both of these groups of terms will be employed together; thus staphylococcus infection of the skin with staphylococcus bacteriæmia or general blood infection. The character of the local lesion in the complete development of any individual infection is best described by the use of the terms "primary," or "secondary" ("metastatic," "subsidiary"); thus "primary staphylococcus infection of the skin with staphylococcus bacteriæmia," or "primary streptococcus infection of the tonsil with secondary streptococcus infection of the appendix," etc., the absence of any descriptive bacteriæmia indicating that a cultivation of the peripheral blood made during the course of the illness was sterile.

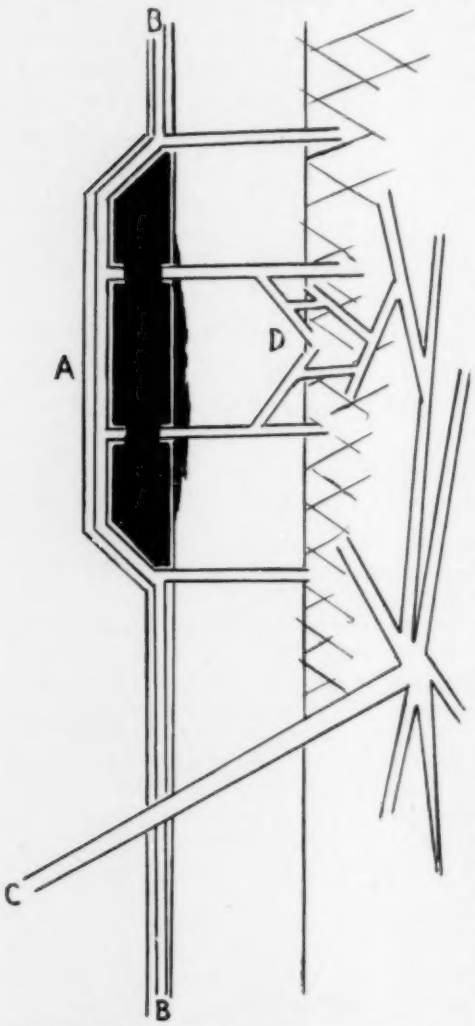

FIG. 1.—Diagrammatic representation of periosteal (B) circulation and that derived from nutrient artery (C). At (D) is the anastomotic area.

There are two fundamentally different classes of cases of acute osteomyelitis: (1) The group in which infection of the bone structure is of an exogenous source and is conveyed from the outside *via* a communication through the covering soft parts; and (2) the group in which infection of the bone structure is of a hæmatogenous origin. Group 2 is of much more importance and of far greater significance than the first group.

There is a third group in which apparently infection plays no part. I refer to the kind illustrated in Fig. 1. A trauma becomes applied to a surface of bone resulting in the rupture of some of the periosteal perforating vessels and in a subperiosteal hæmatoma. A disturbance of the blood supply in a superficial part of the cortex follows and a scale of bone eventually sequestrates. The inflammation surrounding this area is of a reparative nature and has no relation to infection. Such trauma may be accidental or purposeful (operative). The whole process may, however, accidentally or otherwise, be combined with infection.

Group 1.—A. An osteomyelitis can follow as a result of infection introduced from without. In some way—a stab wound or punctured wound, etc.,—a communication is established between the outside of the body and the bone structure. The best examples of this variety are the felons of the terminal phalanges of the fingers in which infection of the bone commonly follows a

puncture with a needle. Infection is introduced here from without, without the agency of the blood stream. In the ordinary civil type of osteomyelitis having its origin in this fashion, the area of bone infected is comparatively and actually small. The process is quickly and sharply delimited and the segment of osseous tissue which dies and sequestrates is inconsequential.

The pathological picture in this variety of case includes an immediate killing off of a circumscribed portion of the soft parts overlying the bone which because of the communicating vascular channel usually extends down to and includes the periosteum and superficial layers of the cortex of the bone. This circumscribed area separates in its entirety and sloughs away, the bone sequestrum coming away with it; thereafter the wound promptly heals. Clinically these processes are accompanied with a great deal of pain.

B. In another variety the bone is involved in an extraneous process occurring nearby because of contiguity of structure. The best example of this is the form of osteomyelitis occurring in the ribs as a complication of an intercostal thoracotomy for empyema. Even though in this type of operation the bone tissue is not exposed, in practically every instance, because of the continued pressure of the drainage tube, the bone becomes bared sooner or later. The process includes a complete pressure necrosis of the covering muscle, fascia and periosteum and an inflammatory process of bacterial origin in the superficial cortical layers of the rib. Most often the process in the bone subsides spontaneously and no sequestration occurs; in a fair proportion of the cases, sequestration does, however, occur.

It must be a very rare occurrence indeed for an osteomyelitis to develop by contiguity of structure from an abscess in the soft parts close by without the mechanism of a pressure necrosis. I have seen many times an abscess situated in close relationship with a bone, but the periosteum has always remained intact and the osseous tissue has not become exposed. Whenever bared bone is felt in the bottom of such an abscess, it can be taken for granted that the process is primary in the bone—usually in its periosteal layer—and that the abscess is a secondary manifestation.

Thoracotomy with rib resection for empyema represents the best example of the group of cases in which bone tissue is directly infected during an operation. Because of this tendency in a large proportion of the cases, it has been suggested by some men that the steps of the operation be so arranged that no opportunity be afforded for infection to be implanted in the open surface of the resected rib; the method suggested has consisted in fashioning a flap from the adjacent soft parts with which the cut surface of the rib can be efficiently covered. The reports available at first were optimistic, but the absence of confirmation since then apparently indicates that the technic described has been found to be not necessary by most operators or has not been successful. Practically, it is found that the infection of the rib is not a serious consequence and serves only to delay the healing of the wound. In obstinate cases radical removal of the infected portion of the rib

becomes necessary subsequently. A bacteriæmia is never demonstrable, except as an ante-mortem phenomenon.

Another variety of this group includes the infected compound fractures of civil life. The process here includes a traumatic baring of bone tissue both on the surface and in the interior upon, and into which, infection is mechanically introduced. In a fair number the infection is, practically speaking, only a contamination and nature aided by the débridement of the wound effectually throws off the contamination so that no consequence of the latter remains either immediately or makes its appearance later. In a few, however, contamination takes root in the exposed bone surface and becomes a true infection. Later a variable segment of bone sequestrates; then the wound promptly heals; this happens in a fair proportion of the cases.

In others of the compound infected fractures in which infection becomes established, the process becomes centred in the callus. As the latter grows in amount and becomes definitely organized, foci of infection become inclosed in the cancellous structure. Clinically this fact is corroborated by the practical impossibility of effectually sterilizing such a wound by the Carrel-Dakin technic and on the appearances of new evidences of infection in the wound after its apparent closure. The infected areas are usually lodged in granulation tissue between the bony planes of the cancellous structure. The chances of an immediate or permanent spontaneous healing depend upon the character of the infecting agent, the resisting powers of the individual, the age of the individual, and certain mechanical conditions in the wound concerning which we shall speak later in this communication.

If wounds of this type are well taken care of promptly and the cicatrization is so controlled that the wound closes from its very bottom, the usual course of events includes a slow but sure healing. The Carrel-Dakin method, however, is of no help, nor does it materially hasten the healing; the reasons for this were pointed out on another occasion (Wilensky, ANNALS OF SURGERY, June, 1922).

In a certain number, operative removal of the infected area and mechanical correction of the mechanical disability are necessary before the wound will heal. In my own experience, it has always happened that once such a wound healed, it remained healed and was not generally subject to the numberless recurrences characteristic of certain other forms of osteomyelitis.

Under ordinary circumstances and as a general rule, cases in the group just outlined are not associated with general blood infections.

Group II.—The ordinary case of acute osteomyelitis results from a bacteriæmia or general blood infection, the origin of which is in the greatest number of cases obscure. In these cases it is thought that the entry point of the infection must necessarily be some surface (skin or alimentary canal) of the body; in actual practice it is assumed that, with very few exceptions (genito-urinary infections, furuncular infections of the skin) this surface is the mucous membrane lining of the alimentary canal at points where collections of lymphadenoid tissue are especially prominent (tonsils, especially—

Peyer's patches—etc.). At the latter areas a lesion need not necessarily be demonstrable. The mechanism of the portal of entry of any infection has been discussed in another communication. In a small minority the bacteriæmia or general blood infection accompanies or follows a definite entity such as typhoid fever; or a definite focus of infection is present somewhere in the body—a phlebitis, a postpartum sepsis, a furunculosis, etc., to which the bacteriæmia or general blood infection is subsidiary and through which in turn the osteomyelitis originates.

In any case the focus in the bone is a fixation point to which the bacteria circulating in the blood are attracted. Commonly there is a single one of these fixation points following which a single focus of osteomyelitis develops. But just as often there are more than one of these foci developing either simultaneously or subsequently the one to the other. When the number of the latter is more than one, some of the fixation points may be located in tissues and structures other than bone, as for instance, in a joint, or in the fascial planes in the musculature of a limb. Under appropriate circumstances, which depend altogether on the character and physical results of the inflammatory process developing at the fixation point, the latter, in turn, forms a point of distribution from which a bacteriæmia or general blood infection may occur and from which subsidiary foci can develop in exactly the same way.

There is no experimental or other evidence which helps in classifying multiple foci developing during the course of an osteomyelitis—or in fact during the course of any infection. It is perfectly possible for the primary lesion to father every secondary or subsidiary focus that may ever develop; and on the other hand, it is just as possible for any secondary focus to in turn form a point of distribution. Sometimes I have thought that I have been able to make the distinction in conditions of the following kind: Several foci develop at approximately one time and these having been adequately treated, undergo an apparent healing. Subsequently trouble develops in one of these foci only and coincident with, or subsequent to, this exacerbation other new foci develop. The fact that one of the original foci is in "active eruption" has made me feel that it in turn is a point of distribution.

The bacteriæmia through which primary or subsidiary foci become established and develop are not always demonstrable. It is well known that these states may be of temporary duration and the presence of bacteria in the circulating blood, even for a short period, is sufficient to infect any local area. It is thought that temporary states of bacteriæmia are constantly occurring even in conditions of health and that the natural forces of the body are amply sufficient to overcome these so promptly that no evidence of them is perceptible in any way. It is also known that during the dressing of any wound—more so, perhaps, with a wound of bone—bacteria may be pushed into the circulation so that a temporary bacteriæmia is present; this ordinarily lasts only a few hours, is occasionally demonstrable and has no clinical signs or demonstrable effects.

CASE I.—The patient had been operated upon previously for an osteomyelitis of the femur. By the end of the second week the wound looked healthy, there were no other foci demonstrable, the fever was practically at the normal level and there was no reason to suspect a bacteriæmia. A blood cultivation which was accidently made within a short time after a dressing showed several colonies of staphylococcus aureus. This, too, was, undoubtedly a temporary bacteriæmia. Other blood cultures were uniformly negative.

While in extraordinary circumstances bacteria can pass through a surface of the body (tonsils, for instance) and multiply in the blood, the available knowledge seems to show that ordinarily bacteria circulating in the blood depend for their existence there primarily upon the presence of an infected thrombus. This was pointed out in another communication. The course of events is one of two: (1) Microscopic pieces of thrombus carrying a number of living organisms break off and circulate through the blood stream until they are disposed of in some way. Sometimes isolated organisms growing on the surface of the thrombus or groups of them in the forms of bacterial emboli are cast off into the blood stream without any particle of the thrombus itself coming away. Clinically, this is a bacteriæmia, as previously defined. Fortunately in most of these instances the natural antibodies destroy the organisms as fast as they are discharged into the circulation and no subsequent effect is noted. In the minority an infected embolus caught into the capillary network of bone tissue and held there becomes a fixation point and furnishes the initial stage of a focus of osteomyelitis. The fact that fragments of the original embolus after it has been arrested in bone tissue or of its secondary thrombus thereafter may in turn break off and circulate in the blood furnishes the physical basis for the occurrence of secondary points of distribution. This explains the statements made in the previous paragraphs. (2) In addition to this the virulence of the bacteria may be sufficient to enable them to multiply in the blood stream.

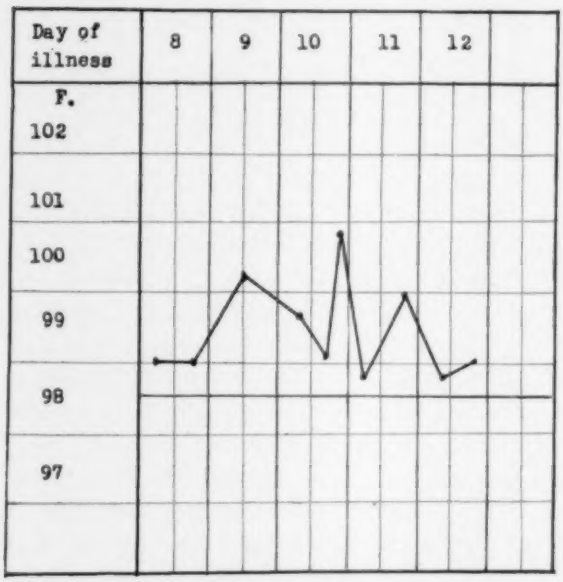

CHART 1.—(Case I.)

The physical characteristics of the infected thrombus-embolus formation (fixation point) and its resultant effects in the bone and the multiplication of bacteria in the blood stream have direct effects on the clinical picture as regards the association of a bacteriæmia.

In actual practice it is found that cases of osteomyelitis can be of three kinds:

(1) In the first variety a focus of osteomyelitis is present with well-marked local signs and symptoms but without any clinical signs of a general blood infection. A bacteriæmia is not present. The physical basis for this variety lies (a) in a primary and temporary bacteriæmia; (b) in the development of a fixation point in a bone; and (c) in the subsequent spontaneous disappearance of the bacteriæmia.

(2) In the second variety a well-marked focus of osteomyelitis is present with abundant local signs and symptoms and, in addition, there are clinical indications of a bacteriæmia as evidenced by the general signs and symptoms and by the demonstration of living bacteria in the blood stream. The physical basis for this variety is the presence of an infected thrombus-embolus formation which serves to keep up a demonstrable bacteriæmia by constantly feeding into the blood stream a comparatively small number of viable organisms. Most commonly, after efficient surgical treatment, the bacteriæmia eventually disappears and a recovery is made. It must be remembered that any of these cases may at any time pass into the third group. The possibility also exists, as mentioned in a preceding paragraph, of the local focus of osteomyelitis in cases of this variety becoming a secondary point of distribution.

(3) The clinical picture of the cases in this group is that of a profound general infection: there is a marked toxæmia. A local focus of osteomyelitis is either not demonstrable at all because of the paucity of local signs and symptoms, or because the latter are hidden in the profound intoxication; or, if present, the local lesion is easily recognized as being of no consequence in the total clinical picture. The physical basis of the picture lies in an extreme and severe general blood infection with highly virulent organisms in which the bacteria are rapidly multiplying in the blood stream and because of which the subject is rapidly being overwhelmed by a tremendous intoxication. The presence of the infected thrombus-embolus formation forms a negligible factor and the few organisms that are derived from this source play only a primary and inciting part in the production of the bacteriæmia; the subsequent multiplication in the blood stream depends on other factors, the most important of which lie in the high virulence of the infecting organism and in the poor resistance of the subject. An endocarditis is usually found under these conditions. In this variety the local point of fixation in the bone plays no rôle in the production of any part of the clinical picture. Usually the inflammatory picture in the bone—the osteomyelitis—is not in a very advanced stage at the time the lesion is exposed, either on the operating table, or, as more commonly happens, in the autopsy room.

In actual disease it seems certain that the cases differentiated in these three groups form progressive stages each from the next preceding group. A case in Group I may pass into Group II; and, conversely, a case in Group II, having been appropriately treated, may retrogress into Group I as it proceeds to healing and recovery. These interchanges are constantly occurring in clini-

cal surgery. A case in Group II may pass into Group III as is previously noted; usually under such conditions there is a continued progression until the eventual fatality. In actual practice cases in Group III must necessarily first pass through the stage indicated by Group II; the time interval may be so short, however, owing to the virulence of the infecting organism, as to be unrecognizable. One can explain the cases that apparently begin with the characteristics of the cases in Group III in this way. In many cases characteristics can be distinguished which belong to both Group II and Group III; and insofar as any case partakes of characteristics not belonging to its group, it differs in its clinical manifestations. I have never seen a case in Group III retrogress spontaneously into Group II; it seems almost impossible to believe that such retrogression can ever occur.

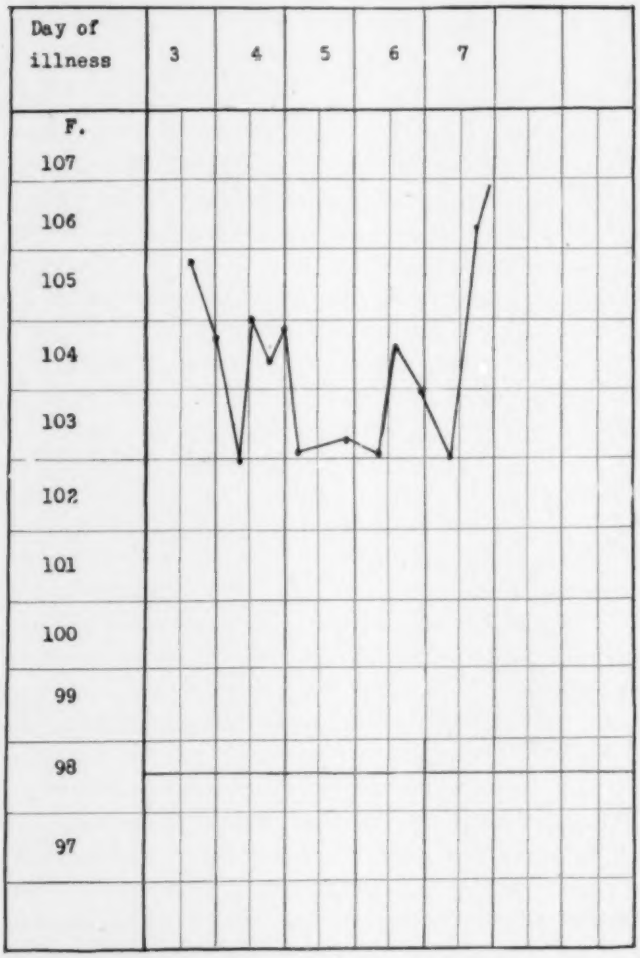

CHART 2.—(Case III.)

The following cases illustrate these various groups of osteomyelitis:

CASE II.—Following the recovery from a lobar pneumonia, a swelling developed over one of the ribs. Upon incision this was demonstrated to be a subperiosteal abscess and necrotic bone was felt in the bottom of the wound. Pneumococcus type I was isolated from the pus. A blood culture was sterile.

CASE III.—A young man was admitted to the hospital with the clinical signs of a profound infection. There were abundant subjective and objective physical signs of a well established focus in one femur which had followed the kick of a horse. A blood cultivation of the peripheral blood showed 25 colonies of staphylococcus aureus per cubic centimetre of blood. An osteotomy was immediately done and extensive drainage was instituted. The pus contained staphylococcus aureus also. The course of the illness is exemplified by Chart 2 and a fatality occurred. Numerous colonies of the same organism were isolated from the peripheral blood before death.

CASE IV.—A young child was seen in a most profound intoxication evidently the result of a general infection. With great difficulty it was established that a focus was present in one clavicle and during the exploration, only a discolored bone with some œdema of the surrounding periosteum was demonstrated. A blood cultivation made before operation showed 10 colonies of staphylococcus aureus per cubic centimetre of blood; one made after operation showed 120 colonies of the same organism; death occurred at the end of the first twenty-four hours.

From what has been said heretofore, it must be apparent that in any given case the presence of a bacteriæmia can be referred (1) to the primary lesion, (2) to its secondary focus in the bone, (3) to the presence of a focus subsidiary to the secondary focus (bone or other) which by itself is capable of creating a bacteriæmia, (4) to the presence of an endocarditis, and (5) to the presence of some other complication capable itself of giving rise to a bacteriæmia or general blood infection. In any given case it is always important to be able to properly classify the bacteriæmia which may be demonstrable. The clinical possibilities are the following:

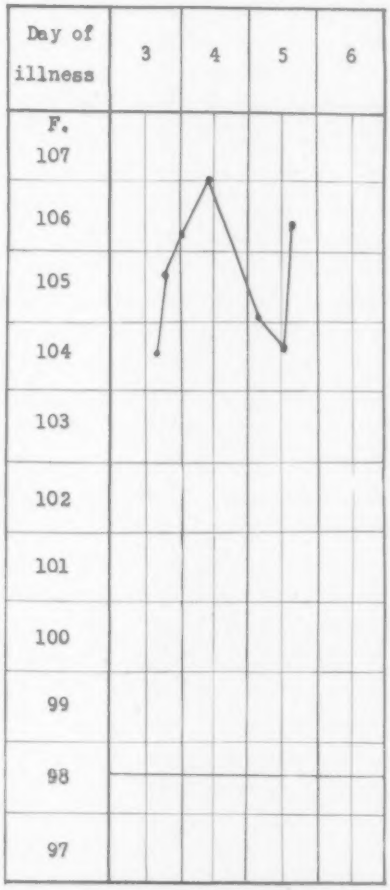

CHART 3.—(Case IV.)

1. In many of the cases a single focus of osteomyelitis only is demonstrable. In most of the cases in this group the comparatively small number of bacteria demonstrable in the blood circulation (plate culture method) indicates that the bacteriæmia results from the demonstrable local lesion. If, following an adequate operation in which the entire bone focus is removed, the blood becomes sterile, it can properly be assumed that the bacteriæmia had resulted from the demonstrable lesion. In some of the cases, however, the bacteriæmia persists for a variable time after operation. When the surgeon is certain that the bone lesion has been so thoroughly removed as to be impossible of causing the bacteriæmia and when the appearance of the bone wound corroborates this impression, the bacteriæmia should be used as an indication that some other focus exists which must be found and removed in order to render the blood sterile. Many times this proves to be the case; but when it does not, the original focus of osteomyelitis should be examined again and revised operatively. If the bacteriæmia still persist and the number of demonstrable bacteria is still comparatively small, an explanation of the bacteriæmia becomes impossible for the moment, although it must necessarily be assumed

that some other focus does exist which is causing the bacteriæmia, and which must be demonstrable. Undoubtedly in some cases an obscure primary lesion exists which serves to keep up the bacteriæmia. Fortunately in most of such cases the natural forces of the body are ample after a sufficient lapse of time to render the blood sterile. A bacterial endocarditis must be excluded in all of such cases.

2. When several foci of osteomyelitis coexist in the presence of a bacteriæmia, the explanation of the latter becomes a matter of exclusion. Similar rules to those outlined in the last paragraph apply.

3. In a few of the cases, comparatively speaking, the primary lesion is demonstrable as well as one or more subsidiary bone lesions. In the majority of the cases primary or other, the primary bacteriæmia disappears after efficient surgical treatment directed towards all of the demonstrable lesions. In a few cases, however, the bacteriæmia persists. Although in some of the latter cases, because of the character of the infecting organism, or because of other reasons, it is possible to say with a fair degree of certainty that the primary lesion is keeping up the bacteriæmia, in all of the others the proper explanation becomes a matter of exclusion also in accordance with the rules laid down.

4. In some of the cases of bacteriæmia a subsidiary focus has developed in a tissue or organ other than bone, or a complication develops which is unrelated to the osteomyelitis. Except in those cases of complication in which the latter is known from previous experience to cause a bacteriæmia or general blood infection, the proper explanation again becomes a matter of exclusion as previously indicated.

In any of these groups it is important to know the relative quantitative degree of the blood infection by an estimation of the number of organisms per cubic centimetre of blood (plate culture method). Then a comparison of any one blood examination, either with preceding blood cultures or with subsequent ones, readily gives a method of distinguishing whether improvement is, or is not, occurring.

5. Any of the local conditions indicated in the preceding four groups may be associated with a general blood infection in which the blood cultivations show that large numbers of viable organisms are circulating in the blood. It is to be assumed under such conditions that the bacteria are multiplying in the blood in addition to whatever else they are doing; the prognosis must therefore be a very serious one. The usual course of affairs includes a steady progression of the general blood infection until a fatality occurs. Very exceptionally improvement occurs and the patients recover. Some patients are admitted to the hospital when the general blood infection has already reached an extreme degree—that is, in a very high grade of infection; such patients should not be operated upon for any of their local lesions as they invariably die within a very short time.

Patients in the first four groups of this classification may, at any time, as has been indicated previously, pass into Group V. They then assume characteristics of this group and the clinical manifestations increase in gravity pro-

portionately and absolutely. It is very rare for the opposite course to be followed.

In the group of osteomyelitis with bacteriæmia, the disappearance of viable bacteria from the blood stream, as demonstrated by the blood cultivations, is many times due to the mechanical operative removal of the part of tissue carrying the infected embolus-thrombus formation. In others, the disappearance of the bacteriæmia is a sudden thing due to the extrusion of the infected clot into the wound surface, or to other non-demonstrable cause of generally similar nature, or to the control of the infection by the relatively strong natural resisting powers of the individual. In still other cases, the bacteriæmia becomes a more chronic affair and persists for some time before finally disappearing; anatomically this must be due to a slow healing of the lesion and the isolation of the infected clot by dense scar tissue, or, functionally, by the slow sterilization of the infected environment by the natural forces of the body.

In actual disease fixation points in any bone must be determined by some kind of local trauma at the given point. I include under the general term of trauma all varieties—mechanical and physical trauma, chemical trauma, etc. In clinical experience the cases group themselves into (a) those in which there is a distinct history of a definite physical trauma and (b) those in which no such history is elicitable.

a. Cases in which the trauma is a distinct physical entity are, of course, very common. I give the notes of one case in which the sequence of events is very suggestive:

Case V.—A young boy sustained a fracture of the radius. There was absolutely no wound of the skin. When the cast was removed at the end of about ten days a sinus was disclosed which led to carious bone. Apparently the boy had been well up to the time he sustained the fracture and there was no indication of any general blood infection. However, a temporary bacteriæmia must have been present probably of the kind previously referred to as the infection must be a hæmatogenous one.

This is an extreme case of trauma. There are many, many other cases in which the degree of the trauma and its extent varies all the way down to minor grades and until it is so slight as to be barely, or not recognizable. I know of one case in which trauma preceding the osteomyelitis was a sprain during a football match.

The physical basis for this consists of a hæmatogenous infection in a gross or microscopic hæmatoma associated with blocking of the circulation at one or more points because of the tearing of the vessels; this is a fixation point for any bacteria carried in the blood stream.

There are other cases in which trauma occurs accidentally during the course of a well-established bacteriæmia. In cases of general infection the mildest trauma is almost certain to be followed by local infection. The common locations are not in the bone: most commonly they are situated in the soft parts of the limbs. In many cases the trauma is so slight as not to be recognized.

b. This group includes all the cases in which there is no history of trauma. Undoubtedly in some, at least, of the cases in this group, trauma was present but passed unnoticed, most probably, because of its slight degree, or because of some other undiscoverable cause.

It is possible that in some of these cases, a certain form of negative or passive trauma is produced by a temporary disturbance of the capillary circulation in a circumscribed area of a bone leading to a temporary localized anæmia. This might conceivably be produced by a fragment of blood clot, which, having become dislodged at some other distant point, becomes caught in the capillary network of some bone. Necessarily the embolus need not carry bacteria; but, once having been arrested in its circulation, it furnishes an ideal environment for the attraction of viable organisms circulating in the blood.

FIG. 2.—Injection specimen of a long bone. Copied from "Untersuchungen über Knochenarterien" by E. Lexer, Kuliga and Türk.

Circulatory changes which cause changes in nutrition are the physical basis for the "chemical traumata" which I mentioned previously. Many cases with no definite etiological history of trauma, undoubtedly, have this form of trauma as a contributing cause.

In actual disease, fixation points in any bone depend a great deal upon the physical characteristics of the blood-vessel structure in the interior of the bone. A typical specimen of the circulation in a long bone is shown in Fig. 2. There is a separate circulation for the diaphysis and for the epiphysis. The circulation of the epiphysis enters most often at more than one point, though very often a main channel can be distinguished. The circulation of the diaphysis is derived from a large vessel, the nutrient artery of the bone which enters a little to one side of the centre shaft. Immediately, the main vessel divides into a number of large branches which pass, some of them upwards and some of them downwards towards either end of the shaft. A diffuse network is formed which supplies the entire interior of the bone and its medullary cavity. Towards the end some of the main branches become end vessels. There is a free anastomosis between the plexus of vessels thus established and the vessels derived from the periosteum through Sharpey's fibres. In a growing bone, with the epiphyseal cartilage still present, there is little direct anastomosis between epiphysis and diaphysis and a relative avascular area results; in a fully grown bone there is an extensive anastomosis between the two.

A fixation point is formed by the arresting of an embolus (or by a thrombus formation) at some point of this vascular network. The actual point depends more on chance than on anything else, and is decided by the physics of the local bone circulation at the given moment. Various pathological pictures result, depending on the size of the plugged vessel, relative position of the plug, the powers of vascular anastomosis, etc., in conjunction with the character, virulence, etc., of the bacteria giving rise to the infection. The dominant characteristics of the pathological picture are: (1) a thromboarteritis or thrombophlebitis, and (2) a necrosis of the bone cells consequent to the disturbance of circulation. The physical characteristics of the pathological picture depend to the largest extent upon the second factor. The following general pathological pictures form the main varieties:

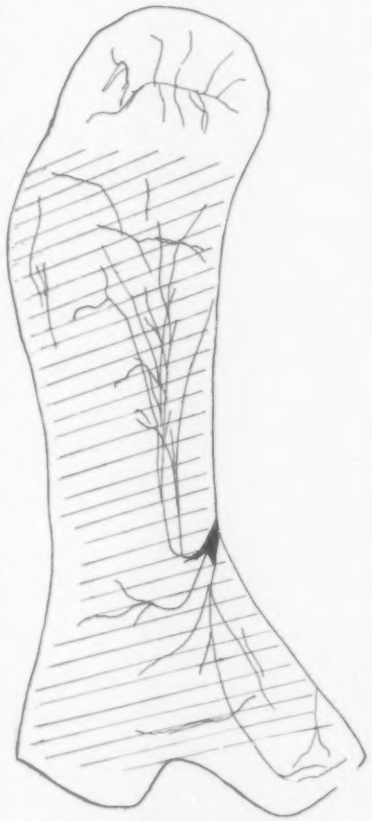

FIG. 3.—Diagrammatic representation of blood supply of long bone after Fig. 2. The shaded area represents approximate area of bone involved with a thrombus-embolus formation (fixation point) in the main stem of the nutrient artery.

I refer again to Fig. 1. In addition to the rupture of Sharpey's fibres, and the subperiosteal hæmatoma infection enters and centres in one or more of the thrombosed vessels. In many cases infection is brought from the bone side of the circulation. Depending on the amount of disturbance of capillary circulation, disturbance of nutrition occurs in the cortex of the bone and usually it is a relatively larger segment of cortex; the resulting sequestration is correspondingly larger than would happen in an otherwise sterile trauma of the kind indicated. On the other hand if the infection enter the clotted area from the periosteal side of the circulation, infection centres in the clot at the relative point, A Fig. 1 and a subperiosteal abscess forms: this is the variety of case in which, after proper incision of the subperiosteal abscess, healing occurs without interruption and with permanency and without involvement of the cortex.

Figure 3 represents conditions when an embolus-thrombus formation occurs in the main nutrient vessel of a bone before its division into its primary branches. Secondary clotting is widespread throughout the entire intraosseous vascular network. The disturbance of blood supply for the given bone is of maximum degree and subsequent necrosis of the entire diaphysis is the rule. The formation of the subsequent protective involucrum is entirely due to the scathless condition of the periosteal circulation; the latter is further fortified by a physiological dilatation of the vessels and by a consequent marked increase in the amount of blood brought to the affected environment. Under the influence of a very great increase in the supply of food thus brought to the periosteal osteoblasts, the dormant activity of the latter receives a powerful stimulus, new bone cells appear, new Haversian systems are formed, and new true bone tissue surrounds the sequestrated portion of the shaft; an involucrum is thus formed.

Figure 4 represents conditions when an embolus-thrombus formation occurs in the course of one of the main branches of the nutrient artery, close to the point of division. The disturbance of nutrition depends upon the degree of intraosseous clotting and upon the capabilities of the collateral circulation. The segment of bone tissue destroyed corresponds closely with these conditions. Involucrum formations follow also along similar lines and depend upon factors and processes outlined in the previous paragraph. In clinical surgery specimens are quite common in which a sequestrum removed at a subsequent operation represents a portion of the circumference of the bone.

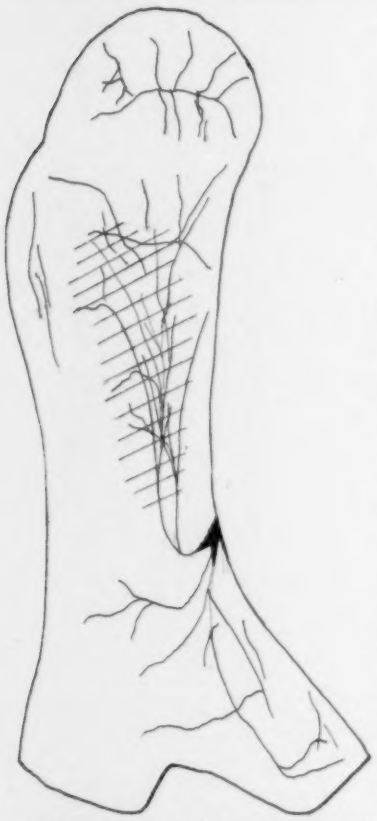

FIG. 4.—Similar to Fig. 3. The shaded area represents the approximate area of bone involved when the thrombus-embolus formation (fixation point) is situated in one of the branches of the nutrient artery.

Figure 5 represents conditions when an embolus is arrested in a terminal branch of the intraosseous network. This variety represents the mechanism of formation of a chronic bone abscess. The arrested embolus is infected and an abscess forms around it. There can be no further spread of the process through the vascular channels of the bone because the plugged vessel is a terminal one. The spread of the abscess locally is comparatively small and is quickly limited as soon as hard bone is reached. Progress through the hard bone is very difficult and in a certain proportion only is the eroding process sufficient to open an avenue into the soft parts. In clinical surgery the evidences of this are found in an acute or chronic osteomyelitis with or without one or more skin sinuses in which the complicated sinus tract leads at one point into the interior of the bone into a cavity containing pus or granulation tissue or both. In the rest of the cases the abscess formed originally becomes localized and is bounded by a firm granulation membrane and the hard cortex of the bone. After a while the organisms in the interior of the abscess die and a sterile collection of pus results. In clinical surgery these form the chronic bone abscesses and depending on the relative time at which the abscess is opened, one may find a chronic bone abscess containing viable organisms or one which is bacteriologically sterile. These latter are the kind that have recently been studied from the therapeutic point of view by Brickner.

Figure 6 represents conditions when the embolus-thrombus formation occurs in one of the small vessels in the cortical portion of a part of the bone. An abundant collateral circulation both from the periosteal and nutrient artery systems limits the disturbance of nutrition to a minimum. The resulting sequestration is, therefore, comparatively small. Involucrum formation from the periosteum is not as abundant as with the other types owing to the lesser intensity and smaller spread of the process and depends for its existence upon causes similar to those previously described. Various grades of this variety exist depending upon the number of small vessels involved primarily and upon the possible spread of thrombosis in the neighboring vascular network.

The conditions just described are the typical varieties that one encounters in clinical practice. It must be remembered that many times the differentiations are not sharply demarcated, so that it is difficult to make the proper

classification. The difficulty results from the fact that cases in one group frequently have characteristics of cases in the other group or groups and the atypical manifestations and pathology results from the fusion of the physical, anatomical and histological characteristics of more than one typical group.

In experimental work it has been recognized that the ordinary form of osteomyelitis is a blood-borne infection and the many attempts to reproduce osteomyelitis artificially have made use of some of the essentially known facts of general infection and of local fixation points. The usual method has consisted in introducing bacteria into the bone directly through an operative wound, or in introducing them through the blood stream by injecting a viable culture into a blood-vessel feeding a given bone. Up to the present time it has not been possible to reproduce a true osteomyelitis in this way. One of two things usually happens: (a) either a severe general infection is produced and the animal promptly dies; or (b) the inoculations are followed by no demonstrable effect whatsoever. It has been recognized that success depends (a) upon employing an organism of the proper low virulence, and (b) upon preparing the local conditions properly. The essential difficulty has existed in the proper preparation of the local area in the bone so that the organisms could be attracted thereto; if that could be secured, the question of securing an organism of properly low virulence could, perhaps, more easily be accomplished. It seems to be correct to assume that this difficulty is an inherent one and exists because of the impossibility of reproducing artificially a fixation point by a thrombus-embolus formation as described in the preceding paragraphs. The artificial attempts always fail because of the following facts: (1) The impossibility of producing successfully the proper grade of bacteriæmia. (2) The impossibility of properly preparing the local field for the embolus-thrombus formation; this depends upon the physics of the local circulation at any given moment, upon the presence of any local trauma is previously described; and upon the fact that even in actual disease the determination of the thrombus-embolus formation must necessarily be a matter of chance. (3) Failure results because at any given moment all factors must be in exact relation with one another for the experiment to succeed. The

FIG. 5.—Similar to Fig. 3. The shaded area represents the thrombus-embolus formation (fixation point) in a terminal vessel near the avascular area. The result is a bone abscess of circumscribed extent.

attempts to reproduce osteomyelitis artificially by boring various kinds of holes in a bone and thereafter introducing bacteria of an artificially made low virulence can only produce a form of osteomyelitis with which one meets naturally when a bone is infected from an exogenous source during a trauma; the percentage of "takes" in actual practice are very small and the "takes" in experimental investigations are even smaller because of those factors detailed above.

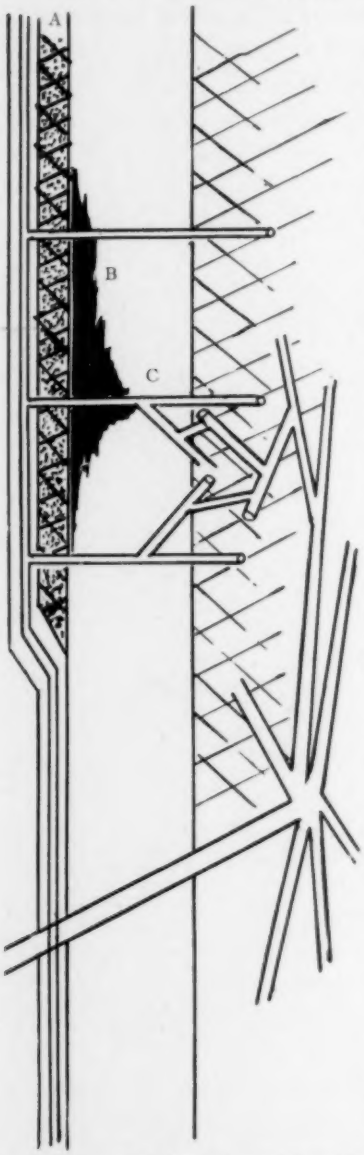

FIG. 6.—Diagrammatic representation of embolus-thrombus formation in a small cortical vessel in the mechanism of acute osteomyelitis. A, Involucrum. B, Sequestrum. C, Approximate position of the thrombus embolus. In this variety the direction of the blocking and the entry of the infection is from the bone side of the circulation and not from the periosteal circulation.

The spread of vascular clotting under the influence of (1) the original embolus-thrombus formation or (2) of persisting infection in the clotted area is an important factor (1) in explaining certain primary characteristics of acute osteomyelitis, (2) in enabling a proper classification of the individual case, (3) in explaining certain obscure manifestations of this disease, and (4) in properly presenting a sufficient mechanism for the apparent or actual spread of the primary lesion.

The possibility of a spreading thrombus formation is corroborated by similar phenomena in the thrombosis of other vessels, notably in the vessels supplying the intestinal tract (superior or inferior mesenteric); one of the factors in the latter disease which makes thrombosis of either of these two vessels so fatal, is the prolixity of the process to spread and involve other loops of intestine.

An important characteristic of an acute osteomyelitis is the impossibility of determining clinically or even upon operative exposure the exact extent of the disease. The physical basis for this exists in the manner and extent of the intraosseous vascular clotting, and of the disturbance of circulation and to the fact that, owing to the physical structure of the bone these changes are not visible at an early stage of the disease—*i.e.*, at the time these cases are usually operated upon. Furthermore, a certain amount of collateral circulation becomes established subsequently to the primary embolus-thrombus formation and its immediate

accompanying disturbance in the bone circulation so that tissue which might first be compromised can later be returned to a normal status; none of this primary or secondary change can be seen by the naked eye or demonstrated by the aid of some physical agent. Attempts have been made to make use of certain dyes by the intravenous use of which it was hoped it would be possible to delimit the involved area; none of these, however, proved successful or practical for reasons which are self-apparent. This disability has been the most powerful agent (1) in preventing a proper classification of the individual case upon anatomic grounds; and (2) in preventing a proper form of operation for acute osteomyelitis.

From clinical evidence it usually seems to appear that the amount of bone involved in any focus of osteomyelitis is many times much larger at the very beginning of the process than sometime later. The physical basis for this phenomenon lies in the relatively large primary involvement of the bone by the embolus-thrombus formation and especially by its accompanying disturbance of blood supply of the interior of the bone and in the secondary contraction of the area of bone tissue thus involved because of the development of collateral circulation. In many of the cases of acute osteomyelitis which one sees, the resultant residue of involvement becomes permanent and remains unchanged during the further course of events of that particular focus of osteomyelitis. The physical basis for this lies in the limitation of the infectious process to the intraosseous vascular area as just determined. In the large number of cases of acute osteomyelitis in which the process enlarges or involves other parts of the same bone, the spread of the process depends primarily upon physical changes in the intraosseous vascular clotting, and in the potentialities for disturbances of the circulation of the bone.

FIG. 7.—Tracing of X-ray photograph of Case VI. A, Old osteotomy. B, New focus and sequestrum. C, Involucrum around new sequestrum.

If the infection persist in a vascular clotted area, spreading of the clot occurs, I give the notes of a case of acute osteomyelitis in which this was very well illustrated:

CASE VI.—In a young girl an acute osteomyelitis developed in one ulna. The process seemed limited and a radical osteotomy was immediately done; the wound was then packed wide open. On the tenth day the packing was removed and the lips of the wound strapped together. Agglutination of the wound surfaces rapidly took place and during the succeeding fortnight the wound apparently healed with the exception of a small superficial sinus. Within a number of days, thereafter however, the wound became reddened and inflamed and an X-ray picture (Fig. 7) showed that the process had apparently spread.

On first sight it might appear from the röntgenographic evidence as if an entirely new focus had formed. But it seems that the proper explanation of this case lies in the spread of the original embolus-thrombus formation. The latter had probably spread in a retrograde fashion until a fairly large trunk of the nutrient artery had become involved in the thrombosis with the physical end result shown in the accompanying tracing (Fig. 7) taken from the X-ray pictures. The compensatory involucrum formation is typical and is well shown. It is quite possible that much of the so-called traumatic-operative destruction of bony wound margins after osteotomy depends upon a similar mechanism.

Any increase in the extent of the intraosseous vascular clotting can occur in one of two ways: In the first of these, the clotting spreads along the vascular channels in the direction in which the blood current flows. Several possibilities follow: (1) A piece of the thrombus breaks off and lodges in a smaller vessel further along; the accompanying clinical manifestation is that of an acute exacerbation of the process which need not necessarily create alarm, or (2) a progressive thrombosis occurs along and in the direction of the vascular path; this practically always indicates a steady, slow progression of the infection along the thrombus. A peculiar form of osteomyelitis results which is characterized by a slow progressive involvement of the osseous tissue; clinically this is seen as a molecular necrosis of the bone tissue in the wound surfaces. Operation—the usual form practiced is a curettage of the bone—is followed by no checking of the process. In this form of osteomyelitis it is found, clinically, that Dakin's solution has no sterilizing effect and the reason for this is obvious. The only efficacious method for controlling this form of osteomyelitis is by a wide excision into healthy tissue.

In the second place clotting may extend along the vascular channels in the direction the reverse to that in which the blood flows, that is, in a retrograde fashion. (This seems to be a common occurrence in case of thrombophlebitis.) As soon as a branching of the blood-vessels is encountered the thrombotic process spreads along the branches either in the direction in which the blood current flows, in which event the course of events repeats those outlined in the previous paragraph; or the extension continues in a retrograde fashion. A number of possibilities follow: (1) If the sizes of the branching blood-vessels are very small, the character of the pathological process and of the corresponding clinical manifestations does not differ from that produced when the clotting spreads along the vessels peripherally as previously described. (2) If a large vessel or a main branch of the nutrient artery is encountered and the latter becomes involved in the clotted area, the manifestations may resemble (a) an acute exacerbation of the process, or (b) those accompanying the development of a new focus. A bacteriæmia or general blood infection may mark the development of either of these two clinical pictures and may or may not be an entirely new phenomenon. A

small focus may in this way be transformed into a large one occupying a considerable, if not the major part of the bone. (3) It is possible for the clotting to extend backward and involve the main nutrient vessel of the bone. The clinical picture becomes very alarming indeed under such circumstances. I give the notes of such a case:

CASE VII.—A young girl was admitted with an acute osteomyelitis in one tibia of very circumscribed extent and with moderate clinical manifestations. A subperiosteal abscess was demonstrated. Sometime later there was an alarming increase in the clinical symptoms both general and in those referred to the local area. It was shown that the whole bone had become involved. Undoubtedly in this case the nutrient artery had become involved secondarily. A bacteriæmia was not present in this case.

More commonly, however, a general blood infection does develop with this extreme spread of the process and it is apt to be of a highly desperate character. This explains the opinion sometimes heard that osteomyelitis should be regarded as something very urgently in need of surgical care in order to prevent any such dangerous development. The opinion is undoubtedly fundamentally correct and while under ordinary circumstances this possibility is an uncommon one, the thought of it should, nevertheless, be constantly borne in mind and should influence our course of treatment in every case of acute osteomyelitis.

The likelihood of any of these various forms of spread of the osteomyelitic process is not limited to the times before operation is done, nor to the early stages of the pathological process. The spread of the thrombosis may occur at any time either before or after operation or between successive operations, however far they may be removed from one another in point of time. Probably this characteristic of osteomyelitis explains the greater number of so-called recurrences, if not all of them. The widely held belief that operative manipulation in bone tissue is likely to spread the osteomyelitis focus is explainable also on the basis of a spreading thrombosis in the bone tissue capillaries.

The likelihood of secondary emboli forming under such conditions of vascular thrombosis in acute osteomyelitis is, of course, very strong. It explains: (1) the formation of multiple foci in the same bone or in different bones; and (2) the exacerbations or recrudescences that one encounters during the course of an acute osteomyelitis. The number of possible ways in which the primary focus could spread whether by progressive thrombosis, or by embolus, is, theoretically, of an infinite number and in actual practice any form of spread of the pathological process in acute osteomyelitis is fully explainable on this basis.

Acute Osteomyelitis in Irregular and Flat Bones.—The biological phenomena of osteomyelitis in bones of a different shape and interior structure than a long bone are essentially the same as those in a typical long bone. Certain differences which are discernible and are common knowledge are directly attributable to the differences of structure in the vascular network

and, to a minor degree, to the differences in the architecture of the individual bone, especially the absence of a medullary cavity. There are two broad groups of this anatomical variety of osteomyelitis: that of the irregularly shaped bone —the vertebra, or the maxillæ, for instance—and that of the flat bones—the bones of the skull. Both of these varieties of bone are devoid of any medullary cavity.

In an irregularly shaped bone the process is exactly similar to that of a long bone, if one leave out of consideration any medullary cavity. It is practically the same as if the process were limited to the cortical and cancellous structure of a long bone. When the nutrient artery is involved practically the whole bone necroses. It is very rare to find an abscess, resembling the acute or chronic abscesses of long bones, in an irregularly shaped bone; the subperiosteal abscess type of osteomyelitis is much more common. Osteomyelitis of irregular bones, especially the parts of the spinal column, are particularly prone to be associated with a high grade of infection. Frequently the source of the general infection is obscure:

An instructive case, taken from the literature (Raimann: Med. Klinik, 1924, vol. xx, p. 670), is the following:

Case VIII.—An eleven year-old patient developed a severe acute illness the dominant symptom of which was pain in the spine. The patient died of "pyemia." The post-mortem examination showed an osteomyelitis of the tenth dorsal vertebra with a large prevertebral abscess. This was apparently a subperiosteal abscess.

The flat bones are structures derived exclusively from periosteal formation and from two opposing periosteal surfaces. Practically speaking, the blood supply of the bone is a double periosteal vascular network. The nutrient artery circulation is negligible. The form of osteomyelitis which develops is determined by the physical characteristics of the vascular network; periosteal and subperiosteal forms of inflammation are the rule. A dominant characteristic of osteomyelitis of a flat bone is that its development immediately destroys the osteoblasts that are present. This explains the absence of any new bone formation; the extreme of this occurs when a defect occurs in the entire thickness of the skull bone; the defect remains permanently. Under ordinary circumstances the integrity of the bone is preserved by the physical fact of the double periosteal origin of the bone; circulation and repair is maintained from the opposing surface to that in which the inflammation is seated; and, as in other bones, the amount of destruction is limited to a superficial sequestration.

Group III.—A very important group of cases of osteomyelitis is made up of cases in which infection is first introduced from without by contiguity of structure or during a trauma, and is later associated with a general blood infection.

The best example of the former is the form of osteomyelitis of the mastoid process which follows infection of the middle ear. The process includes an infection of the middle ear which spreads to the lining mucous membrane of

the cells of the mastoid in all of their ramifications, with a secondary involvement of the bone itself. Changes in the small blood-vessels of the bone—collectively, the so-called osteo-phlebitis of Koerner—must be assumed in rare cases to explain the occurrence of a metastatic focus, when the large lateral sinuses are normal. As the process develops the wall of the lateral sinus becomes involved in turn, either by direct contiguity or by way of communicating blood channels (extension of Koerner type) and thrombosis occurs, the thrombus being either parietal or occluding. The studies of Libman and his co-workers have shown that under such conditions bacteria may be cultivated from the blood stream. The characteristics of such a blood infection include: (1) an infected blood clot, which feeds into the circulating blood a comparatively small number of organisms, as demonstrated by the number of colonies which can be cultivated by the plate method; (2) the development of secondary metastatic deposits in various parts of the body, notably in the bones and in the joints; (3) the possibility of completely curing the condition by eradication of the disease in the mastoid process and by prevention of the infected blood clot from feeding organisms into the general blood circulation by ligature of the jugular vein on the cardiac side of the clot and complete drainage of the lateral sinus with excochleation of the infected clot. The last factor depends for its efficiency, and is based upon an early recognition of the basic condition and upon prompt surgical intervention. There are many instances in which after operation a disappearance of the blood infection does not take place, or reappears after it had once disappeared; these exceptions are due to primary or secondary involvement of the petrosal sinuses in the thrombotic process, or, possibly to association with the Koerner type of osteophlebitis.

The usual bacteriological findings include staphylococci, streptococci, pneumococci and atypical forms related to them.

Gunshot and military wounds of bones form a large group in which general blood infection may appear subsequently as part of the clinical picture. The process in the bone is that typical of the ordinary forms of osteomyelitis, especially that complicating fracture and the characteristics of the pathological picture depend on the kind of infecting organism, its virulence and the dose of organisms delivered with the trauma. The organisms found belong to the broad group customarily found in the intestinal canal; the colon group and gas-producing organisms predominate. This is due to the filthy conditions of military life and the fact that so frequently pieces of clothing are carried into the wound in front of the projectile.

Thrombosis of the bone vessels form a prominent part of the pathological picture and from these blood infections appear. In military wounds general blood infection is frequent. The important point to remember is that when they occur, they are consequences and not primary factors in the bone disease, even though the shortness of the time interval might mislead one.

Gunshot and military wounds of bones in which osteomyelitis subsequently appears form a subgroup of the large group of infected compound fractures occurring under any and all conditions in which contamination from the outside becomes rooted as an infection of bone tissue (osteomyelitis). In civil life, too, it occasionally happens that an ordinary infected fracture subsequently becomes complicated by the presence of a bacteriæmia or general blood infection. In civil life such complicating blood infection of compound infected fractures are usually of the most severe kind and fatalities are the rule and not the exception. Under military conditions such complicating general blood infections are also of the most severe kind and with few exceptions they are fatal.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 8, 1925

The Vice-president, Dr. Walton Martin, in the Chair

PARTIAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH

Dr. Charles H. Peck presented a man, sixty-two years of age, who was admitted to Roosevelt Hospital, December 11, 1924. For two months only before admission he had suffered from belching of gas, sour stomach, eructations, loss of appetite, loss of weight. There was no actual pain. Debility and loss of strength marked. Had vomited only twice prior to admission. Bowels constipated. Complains of hemorrhoids.

His previous history was unimportant, except that five years ago he had a cyst of the thyroid removed by Dr. C. N. Dowd.

On admission his X-ray plates showed a gross filling defect in the antrum of the stomach with a 50 per cent. gastric residue at six hours.

At operation performed December 18, 1924, the stomach was found to contain a very large mass occupying the lesser curvature from the pylorus to within an inch of the cardia. There was a very large gland at the upper end of the lesser curvature. There were no nodules in the liver; no definite adhesions to the pancreas; no secondary growth found anywhere. Fully three-fourths of the entire stomach was removed; and an anterior gastro-jejunal anastomosis made, with the jejunum about twelve inches from its origin. The reaction was very moderate, and he made an uninterrupted recovery, after a transfusion done on the second day. He was discharged March 21, when he had gained seven pounds in weight. He was eating light diet without distress, gaining strength steadily. General condition excellent. He is feeling perfectly well at the present time. Sections of the tumor showed colloid carcinoma of the stomach with metastasis to the glands of the greater and lesser curvatures.

Dr. Charles Gordon Heyd remarked upon the choice of the anterior Polya in preference to the posterior. In his experience the retrocolic operation had been associated in one case with acute intestinal obstruction from retraction of the stomach and jejunum upward and he thought this complication was obviated by the anterior method.

Dr. Henry H. M. Lyle said that a number of years ago he did a posterior Polya and the patient died. At autopsy it was found that the suture line had held perfectly but that the patient had died from a high ileus with enormous dilatation of the remaining portion of the stomach. Since this happening when he does a Polya he employs the anterior with an entero-enterostomy.

Dr. Nathan W. Green considered that the post-operative improvement in this case, only four months since the operation, showed that the condition one had to deal with in cancer of the stomach was frequently divided into two parts: one due to mechanical obstruction, and the other due to toxæmia. On removal of the growth the toxæmia appeared to have been

removed also. That might be the chief reason why the patient seemed to have been benefited so much more than by the simple correction of the mechanical obstruction by a gastro-enterostomy.

It would seem justifiable therefore to make more frequent attempts to remove these growths on the border line of operability, because of the improvement after the removal of the toxic absorption, even if one could not in many cases hope for more than a few months' remission.

Dr. Edwin Beer said that it was astonishing how large a number of carcinomatas of the stomach in this community reach the operating table in an inoperable condition. It was difficult to say where the fault lay. Apparently, however, the condition is recognized too late in the great majority of cases. In this patient presented by Doctor Peck, in which he had obtained a brilliant post-operative result, the disease was most extensive so that the operator had hesitated before making the very wide resection. It would be of interest to know how often operable cases of carcinoma of the stomach are seen by members of this Society. In his own service at Bellevue Hospital less than ten per cent. of the cases reach the operating room in a condition where resection might be justified. This is a rather serious situation when one considers the results that have been reported in this disease from some of the clinics of the Middle West.

Dr. George Woolsey said that in one case where he did an anterior operation he was obliged later to make an entero-anastomosis. He saw a patient recently in which the growth had not been so extensive as in Doctor Peck's case, but which had required an extensive operation. He did not believe when he operated in 1913 (eleven and one-quarter years ago) that the outcome would be favorable, but when seen a few weeks ago the man had been well up to last November, but he now has gall-bladder trouble. The X-ray shows the stomach has been removed to the line of the vertical portion of the lesser curvature and still further on the greater curvature. The operation was a Billroth II and the remains of the stomach appear normal in the X-ray.

Dr. Hermann Fischer said that during the last five or six years the antero-colic Polya-Balfour modification of the Billroth II had been his operation of choice in resections of the stomach for ulcer or carcinoma. His experience has been uniformly satisfactory. He prefers the Polya to any other method where he cannot do the Billroth I.

Dr. Allen O. Whipple mentioned the case of a patient who four years ago had a large growth involving the lesser curvature. The lymph-nodes extended so near the cardia that it did not seem as if there would be room to apply clamps. An anterior Polya was done and the man continued well for forty-seven months. Suddenly, six weeks after a follow-up visit, he developed symptoms of epigastric distress and had a definite recurrence in a palpable mass. During the four years he had remained well and had returned to work.

Doctor Peck, in closing the discussion, said that he did an anterior Polya instead of a posterior because it was the only operation suitable as the

growth was so high. He has done a moderate number of posterior Polyas and when resection can be done further down he thinks it is a suitable operation. He had not had any post-operative obstructions in his cases. He had not presented this case as a cure but as an extensive resection in which he felt it might well have been an error in judgment to attempt to resect at all. The man has been given a little extension of life and comfort, and even though it recur within a year it has been worth while. In answer to Doctor Beer, Doctor Peck said he saw few cases suitable for resection. In one of his early cases of carcinoma the man lived fourteen years after resection and died at the age of eighty of prostatic disease. There are not many such cases. Shortly after this operation was done, another man, seventy-four years of age, was operated on for a growth as extensive as this, reluctantly and only when strongly urged by the patient and his family, and, except for an operative accident, he might have recovered. The resection was fully as extensive as in the case shown this evening. But there was one difference, the carcinoma had perforated against the body of the pancreas and there was quite a wound in the body of the pancreas on removal of the growth. This constituted a serious accident and, although the man went for nine days and had advanced to articles of soft diet, he suddenly developed a secondary hemorrhage from the pancreatic vessels and died. The actual resection can be done safely in some of these extensive cases, and one can occasionally get sufficient benefit to make such an operation worth while.

INTESTINAL OBSTRUCTION AFTER APPENDECTOMY

Dr. John Gerster presented four cases of intestinal obstruction following appendectomy from a few weeks' standing to several years after operation.

S. W., a boy of thirteen years, had appendectomy for acute gangrenous appendicitis, March 9, 1923. No drainage. Uneventful convalescence. Discharged March 20, 1923. On April 25, 1923, seven weeks later, was admitted to Mt. Sinai Hospital for acute intestinal obstruction of 24 hours' duration. Through a right paramedian incision several bands of adhesions binding together the lower portions of the ilium were divided. The obstruction was relieved. The contracted intestine below the point of obstruction remained contracted for some time after separation of the adhesions. The boy made an uneventful recovery, being discharged May 8, 1923.

H. C., a boy of fifteen, had appendectomy with drainage for acute gangrenous appendicitis and peritonitis, March 7, 1917. Was discharged March 24 and admitted a few days later with a volvulus of the terminal part of the ilium due to post-operative adhesions. The volvulus was reduced and adhesions divided. All mesenteric glands were enlarged and there was much free fluid in the peritoneal cavity. Six years later, August 11, 1923, he was admitted to Mount Sinai Hospital with intestinal obstruction of four days' standing. Upon opening the abdomen through the original scar, a dilated loop of gut densely adherent to the scar was nicked. This wound was repaired. Several loops of small intestine entangled in adhesions were freed, the obstruction was relieved and the patient made an uneventful recovery, being discharged August 26, fifteen days later.

Louis K., a man of twenty-eight years. In October, 1921, he was operated on for perforated gangrenous appendicitis with abscess. A fecal fistula

developed afterward, closing spontaneously. Three years later, October 9, 1924, he came into the hospital with an intestinal obstruction of 24 hours' standing. There was a post-operative ventral hernia in the original wound through which a laparotomy was performed. A band between the cæcum and the small gut in the right iliac fossa was the cause of obstruction. As soon as this was divided, the collapsed gut distal to it immediately filled under the eye. The ventral hernia was repaired. He made an uneventful convalescence for twelve days, then cramps, moderate distention and vomiting occurred. These were relieved by colon irrigations. After a few hours they commenced again and were again relieved in the same manner. This kept up for two days and finally these measures were of no avail and, October 23, fourteen days after the first operation, through a long right paramedian incision the abdomen was reopened; five distinct separate areas of adhesions were exposed and adhesions were divided. In three of these areas obstruction was actually present and in the other two it might have subsequently developed. Two were in the right iliac fossa, one was in the pelvis, one in the left iliac fossa and one in the right hypochondriac region. The wound became mildly infected so that the patient was kept in bed for twenty-five days after the second operation; forty days after the first operation. First operative wound had healed smoothly. Otherwise his convalescence was uneventful and he has remained well since.

Leon K., twenty-eight years of age. On March 25, 1923, he was operated on for acute suppurative appendicitis. The wound healed by primary intention and he was well until twenty-two months later, when on January 13, 1925, he was admitted with acute intestinal trouble of twenty-four hours' standing. Through a right paramedian incision, five inches long, a band of adherent omentum constricting the ileum was divided. He was discharged January 30, seventeen days later, after an uneventful convalescence.

All these cases were from the service of Dr. A. A. Berg at Mount Sinai Hospital. Doctor Gerster remarked that the primary operation in three of these four cases was performed by different house surgeons. The constricting bands noted as causing intestinal obstruction in three of the four cases were of omental origin. A long strand of omentum had become attached deep in the abdomen close to the root of the mesenteries, adjacent loops of small intestine. Beneath this band another loop slipped in and became strangulated.

It would therefore be wise to make sure that, after removal of the appendix, as much of the omentum as can be reached, should be gently pulled out of the laparotomy wound and then replaced just beneath anterior abdominal wall, so as to prevent a long finger of omentum becoming adherent deep down close to the mesenteric root of the small intestine and thus leading to possible future trouble. In the case of obstruction following acute diffuse peritonitis the scattered areas of adhesions were found too far away from the original wound to have been caused in this way.

Dr. Howard Lilienthal discussed the importance of avoiding post-operative adhesions. The speaker had for many years been operating without the use of gauze in the belly, using instead big pieces of rubber dam. When the rubber dam is pulled away from the gut one does not see the pattern of the fabric on the gut wall. He had made the rather rough experiment of taking a piece of gauze after a surgeon had used it, washed it in water,

centrifuged it and done the same with a piece of rubber dam, and the number of endothelial cells found in the gauze specimen was infinitely larger. He was convinced that rubber dam used instead of gauze would prevent to a very great degree post-operative adhesions. Where a drain is needed a layer of rubber dam can be used with gauze inside of it.

Dr. Robert T. Morris said he had seen a number of cases of intestinal obstruction following the use of gauze packing in former years, but he now believed that as a result of attention being called to the wrong of using gauze in the peritoneal cavity, post-operative adhesions are very much less frequent than they formerly were.

Dr. Hermann Fischer had seen four cases in one year, at one time, but in the last three years he has not seen any. Early diagnosis is of great importance. The patient is fortunate who falls into the hands of a physician who recognizes the condition in the beginning. He had a case in his own family, his young son who was operated upon during the interval for appendicitis and apparently had made a good recovery. One year later he was suddenly seized with intense abdominal pain and vomiting. After a few hours with careful observation, the diagnosis is usually not difficult, but in the beginning of the attack the condition is very deceptive. Although several colleagues advised against operation, it was decided to operate immediately and the boy was well in six days.

At the operation it was found that a small band passing from the cæcum to the side of the pelvis was the cause of the obstruction. This case shows that it is not always a severe peritoneal infection which is the cause of formation of bands and adhesions, but that they also can form after a comparatively simple and uncomplicated abdominal operation.

Dr. Willy Meyer said that one of the principal points in avoiding post-operative adhesions certainly is to avoid using dry gauze within the abdomen. He doubted that any surgeon is still employing it to-day. Moist gauze is used at the Lenox Hill Hospital. Rubber dam may be better still. The protection of the healthy intestine certainly means a great deal; pads of moist gauze can afford such protection. The main point is early operation in appendicitis, as early as possible. When a patient thus operated on later or suddenly complains of acute intermittent intra-abdominal pain without rise of temperature, one of the first thoughts of the attending physician or surgeon should be intestinal obstruction. It is the most frequent cause. Such a patient is a hospital case immediately. If the patient is then carefully observed and operated on, and the operation is performed without delay, one will usually achieve the same result as was shown in the cases presented here this evening.

RESULT OF DEEP X-RAY TREATMENT OF INOPERABLE RECURRENT BREAST CARCINOMA

Dr. Willy Meyer presented a woman, fifty-three years of age, who came under his care in 1908, at the age of thirty-six, with all the signs of carcinoma of the breast. He did the typical radical removal according to the New York method. The patient made a good recovery with perfect use of the

arm. She reported thereafter at regular intervals, remaining well. In 1920 she omitted to present herself. When she called in the spring of 1921 she had a swelling over the left first rib involving the clavicle. It was a regional, inoperable recurrence. The patient was referred to the Radiologic Department of St. Luke's Hospital, where Dr. Francis Carter Wood took care of her. She made her visits regularly, and carefully carried out every order given to her. In the summer of 1923 she suddenly developed an acute erysipeloid with an eczema-like eruption of the skin. The skin of the entire region gradually became firmly infiltrated and has remained in this condition ever since. Gradually, during one and one-half years, the ulceration over the first rib closed; she never developed supraclavicular gland involvement. At present there is no intra-abdominal nor intrathoracic metastasis. For the present the patient is apparently again cured. This is a rather unique case, inasmuch as the bone, having been fully involved, with a malignant ulceration present, has healed under X-ray treatment.

How can one explain such an occurrence? Cancer cells must evidently be dormant in the tissues, perhaps from the time before the operation, until something awakens them and they then resume their activity. But what does, what can awaken them? It is totally mystifying unless one agrees with the speaker and others that the endocrine system plays a great rôle and is responsible for the occurrence, at least in part.

As to the five-year period of freedom from recurrence accepted as denoting a "cure," it may be wise to change this and speak only of the number of years in which new manifestations of the original disease have been prevented. Still, almost every surgeon has seen freedom from cancer in some of his patients for a long time after operation. Personally, Doctor Meyer had observed such long freedom from recurrence in a number of cases of radical operation for cancer of the breast, in some instances for thirty years or more; so that after all one had the right to speak of a "cure" in cancer. It would seem that the virulence, the degree of malignancy, is the deciding factor.

OPERATIVE TREATMENT FOR ARTHRITIS DEFORMANS OF THE HIP

Dr. Royal Whitman read a paper with the above title, for which see Annals of Surgery, vol. lxxxi, p. 1108, June, 1925.

Doctor Whitman presented two patients to illustrate his paper. The first, a woman of forty-eight years of age, had suffered from pain and increasing disability for twelve years and when first seen used crutches. The operation was performed November 12, 1923. She now attends to her household duties, has practically no pain, and walks with a scarcely perceptible limp.

The second patient, a man fifty-eight years of age, was operated on November 19, 1923. His disease of several years' duration had become extremely painful and disabling. He said it sometimes required ten minutes to rise from a chair because of the extreme pain and stiffness in the joint. His pain has been completely relieved. There is but slight limp and he states that he can walk ten miles without ill effect.

In reply to questions, Doctor Whitman said that the removal of osteophytes about the margin of the acetabulum was a question of judgment since in some instances in which there was considerable destruction of the upper margin they increased stability.

There was never in these cases ankylosis as he understood the meaning of the term, although the motion might be very limited by destructive changes and by the formation of osteophytes. The object of the reconstruction operation was to reduce the size of the bearing surface of the femur, and by abducting the limb to thrust it deeply into the acetabulum where the cartilage was in fairly normal condition.

The reconstruction operation was designed for the better class of patients as regards age and local condition. In cases of extreme deformity with upward displacement the pain, dependent upon mutual friction, was much less and the patients having become accustomed to the disability would rarely consent to operative treatment.

Stated Meeting Held April 22, 1925

The President, Dr. Eugene H. Pool, in the Chair

PENETRATING GASTRIC ULCER. PARTIAL GASTRECTOMY

Dr. Richard Lewisohn presented a man, fifty years old, who was admitted to Mount Sinai Hospital, October 21, 1923, with the following history: He had an attack of epigastric pain three years ago. He was then symptom-free until three weeks prior to his admission, when symptoms recurred. He had severe pains one hour after meals, lasting about an hour. These pains were relieved by taking food. Ewald: free HCl 60, total acidity 85. X-ray examination showed a large penetration situated on the lesser curvature at the reëntrant angle, with a marked delay in the motility of the stomach. The röntgenologist stated that "in view of the size of the defect and the age of the patient, a new growth must be thought of."

Operation revealed a large ulcer situated at the posterior wall and densely adherent to the pancreas. On account of the extensive adhesions which reached very high up, the usual procedure was modified, and the resection was started by division of the duodenum. The duodenal stump was closed in three layers. It was then possible to divide the posterior adhesions under the guidance of the eyes, and thus avoid injuring the median colic vessels. The base of the ulcer was left on the pancreas and about two-thirds of the stomach was resected. The gastric end was closed in three layers and a retrocolic button gastro-enterostomy was performed. The specimen showed a large ulcer, about 6 cm. in diameter. The patient made an uneventful recovery, and left the hospital, November 17, 1923.

Microscopic examination showed a callous ulcer. The button was passed December 30. The patient has been in perfect health since the operation. He has gained about forty pounds. Ewald test meal, taken last week, shows: free HCl, 0; total acidity, 15. X-ray examination shows normal motility of the stomach.

Doctor Lewisohn stated that the rational surgical treatment for gastric ulcers was undoubtedly partial or subtotal gastrectomy, the only method which assured a permanent cure for the patient.

BLEEDING DUODENAL ULCERS. PARTIAL GASTRECTOMY

Doctor Lewisohn showed two patients who had suffered from repeated gastric hemorrhages and were cured by partial gastrectomy.

Case I.—A. K., thirty-three years old, was admitted to Mount Sinai

Hospital, complaining of epigastric pains for seven years. Four months before his admission he noticed tarry stools. Three months ago he fainted on the street, and was taken to another hospital, where he stayed six weeks. He vomited coffee-brown material during his stay at this hospital, and his anæmia was so severe that a blood transfusion was performed. In the last few weeks prior to his admission to Mount Sinai Hospital, he felt very weak and complained of epigastric distress. On admission the hæmoglobin was 84 per cent., the stool was negative for blood. Ewald: free HCl 60, total acidity 85. X-ray examination showed an annular constriction about three-quarters of an inch from the pylorus, without residue. Diagnosis: duodenal ulcer.

An exploratory laparotomy July 30, 1924 (Doctor Lewisohn), failed to show evidence of an ulcer either in the stomach or duodenum. The stomach was incised and a finger introduced into the duodenum. The mucosa appeared perfectly normal. The gastrotomy opening was closed. A small varix in the liver suggested the possibility of œsophageal varices as the source of the gastric hemorrhages.

The patient made an uneventful operative recovery and left the hospital August 16.

He was readmitted to the Medical Service two weeks later, on account of hemorrhages which recurred the day previous to his readmission. In the afternoon following his admission, the pulse went up to 160 and became almost imperceptible. The skin was cold and clammy. He vomited one quart of old blood. He got over the acute attack, but continued to lose small amounts of blood during the next few weeks. He required another blood transfusion, as his hæmoglobin had gone down to 40. Another X-ray examination (October 17) showed the same findings as before. He was transferred to the Surgical Service and re-operated November 5. His hæmoglobin at the time of operation was 50.

The operation was performed without general anæsthesia. After careful infiltration of the abdominal wall with ½ per cent. novocain, the peritoneal cavity was entered. Extensive adhesions were separated and the round ligament was divided. A small flat induration was felt on the superior wall of the duodenum, between the first and second part of the duodenum. Many retrogastric adhesions were encountered. A partial gastrectomy with Hofmeister anastomosis was performed. The specimen showed a flat duodenal ulcer, about the size of the finger nail of the fifth finger. Microscopic examination: callous ulcer.

The patient made an uneventful recovery and has been free from gastric symptoms since the operation. Ewald test-meal shows: free HCl, 10; total acidity, 25. X-ray examination shows a normal stoma and no delay in motility.

Case II.—O. L., twenty-seven years old, was admitted to Mount Sinai Hospital, November 12, 1924. He had suffered from epigastric distress and gaseous eructations for four years. He had noticed tarry stools on several occasions. An exploratory laparotomy was performed in another hospital three years before, through an upper abdominal incision. The appendix was removed. The pains had grown worse since the operation and were relieved by taking food and bicarbonate of soda. He vomited occasionally. During the last two years he had lost thirty-five pounds, and had repeated hemorrhages (tarry stools). No hæmatemesis.

Upon his admission to Mount Sinai he presented a moderate degree of anæmia, and a ventral hernia as a result of the previous operation. X-ray examination showed a duodenal ulcer.

The operation was performed November 2, 1924, under gas-oxygen anæsthesia. The scar was excised, and dense adhesions were divided. A flat ulcer was felt in the first part of the duodenum, with a slight œdema around the ulcer. A partial gastrectomy was performed. The vessels were ligated, the stomach was cut across, just above the reëntrant angle. The duodenum was divided between the first and second parts of the duodenum, and was closed in three layers. At this point the patient stopped breathing, and artificial respiration had to be resorted to. In order to finish the operation as rapidly as possible, the cut end of the stomach was closed in its entirety, and a button gastro-enterostomy was performed. The ventral hernia was then repaired, and the patient returned to the ward. Microscopic examination: duodenal ulcer.

During the first thirty-six hours convalescence was very stormy. The patient vomited some blood, and his blood-pressure fell rapidly. A transfusion of citrated blood (500 cm.) was given five hours after operation. The condition of the patient looked very hopeless the next morning. However, he rallied during the next twenty-four hours, and made an uneventful recovery, aside from a left parotitis, which subsided automatically.

He is now perfectly well. X-ray pictures taken in February, 1925, show normal conditions. The Ewald test-meal, taken upon his discharge, showed free HCl 15, total acidity 32. Reëxamination in April showed free HCl 0, total acidity 25.

Doctor Lewisohn stated that he presented these two patients before the Society in order to emphasize two points: (1) Careful palpation of the duodenum, even with the aid of a gastrotomy, may fail to reveal a lesion, in spite of the fact that an ulcer is present. These ulcers have a typical life cycle. They flare up and subside at different intervals. At the time of the primary operations these ulcers had healed temporarily, and the fine scars evaded detection. A few weeks later the ulcers were again active, and caused serious hemorrhages.

(2) Partial gastrectomy presents the only method of permanent and radical cure of bleeding duodenal ulcers. It is not advisable to operate at the time of an active and profuse hemorrhage, as we could then only resort to palliative operations (gastro-enterostomy, etc.), methods which fail to cure the ulcer and to remove the danger of recurrent hemorrhages. These patients should be subjected to a partial gastrectomy after the acute symptoms have subsided, and before a repetition of the hemorrhage may cause a fatal outcome.

Dr. John A. Hartwell said that he recently had a case in Bellevue that was almost a duplicate of Doctor Lewisohn's first presentation. The interesting point was that instead of doing a posterior Billroth II, he did an anterior Polya. After the operation he found that the stomach had dropped so far to the left side that it had passed over the splenic flexure, an ideal position for proper drainage of the stomach.

The jejunum continued in a straight line with the transverse duodenum, the lesser curvature was in contact with the proximal end of the jejunal stoma and the greater curvature with its distal end. Hence there seemed to be no possibility of viscious vomiting and no entero-enterostomy was done. The convalescence was without untoward incident and no vomiting has

occurred since. It would thus seem that when the lesser curvature is divided high up, the swing of the stomach is such that an antecolic Polya is an ideal method of operation.

Dr. Hermann Fischer mentioned a case in which the patient not only gave the typical history of a duodenal ulcer, but in which the röntgenologist, Doctor Stewart, had made a positive diagnosis of duodenal ulcer. On opening the abdomen, stomach and duodenum and gall-bladder were perfectly normal on inspection and palpation. No adhesions anywhere. On the strength of the positive X-ray diagnosis an incision was made into the stomach close to the pylorus. A finger was inserted into the duodenum and the inside of the gut carefully palpated down to the papilla. No anomalies could be detected. Not satisfied with the negative findings, the speaker introduced a sigmoidoscope and a careful search was made without finding anything abnormal. The incision into the stomach was thereafter closed and as there was nothing further to do, the abdominal incision was sutured. The patient left the hospital after ten days, but returned four weeks later complaining of the same symptoms.

Several months later he was operated upon in the Presbyterian Hospital by Doctor St. John, who found the ulcer, excised it, and performed a short-looped iso-peristaltic gastro-jejunostomy.

This experience shows that a small ulcer can easily be overlooked, and it seems the best policy in such doubtful cases is to open the duodenum and inspect it directly.

Dr. De Witt Stetten said that he had had an experience similar to that of Doctor Fischer in overlooking an ulcer of the duodenum even when a pre-operative diagnosis of that condition had been made and the ulcer had been specifically sought for at operation. He cited a case in which the patient, a man fifty-four years of age, had suffered severe epigastric pain, rather characteristic as regards type and relation to meals of duodenal ulceration. X-ray examination confirmed this impression. There had been no hemorrhage. At operation a much diseased, thickened gall-bladder was found to which the omentum was densely adherent. Careful palpation revealed no evidence of ulceration in the stomach, pylorus or duodenum. On the assumption that the gall-bladder was responsible for the patient's symptoms, a cholecystectomy was done. The patient improved greatly after operation and for a time was free from pain so that it was thought he had been cured by the removal of the diseased gall-bladder. About two months after operation Doctor Stetten was called to see the patient because of a severe gastric and intestinal hemorrhage from which he recovered. About eight months after this hemorrhage he was operated on at the Mt. Sinai Hospital and a large ulcer of the duodenum adherent to the pancreas was found. Doctor Stetten is also of the opinion that in questionable cases where palpation is inconclusive the stomach or duodenum should be deliberately opened to verify or disprove the presence of ulceration.

HÆMOLYTIC STREPTOCOCCUS GANGRENE OF ARM

FRACTURE OF THE NECK OF THE HUMERUS

DR. SETH M. MILLIKEN presented a woman, sixty-one years of age, who was admitted to the Reconstruction Hospital, January 26, 1925. Three days before admission she slipped on the ice and fell with her right arm abducted. At the time of admission she was carrying the right arm in a sling and unable to move the right shoulder, which was swollen and tender. There was no palpable deformity but a good deal of subcutaneous hemorrhage.

The arm was put up in abduction with skin traction on a Blake board and Balkan frame. The arm was gradually abducted to an angle of about 95 degrees. This position was maintained for fifteen days, the patient being quite comfortable. Voluntary motion was encouraged on the twenty-second day. The traction was removed on the twenty-fifth day and patient thereafter encouraged to use arm in all directions. She was discharged with good function February 28.

When seen March 30 she showed full function except for limitation in external rotation. Physiotherapy has been continued twice a week during the last month. The X-ray showed an oblique fracture at the junction of shaft and head of right humerus with impaction and slight inward rotation of the head of the bone.

DOCTOR MILLIKEN said that he had presented the patient to show the advantages of the traction method. She had full function at the end of seven weeks.

DR. ROYAL WHITMAN said that the disability after injury to the shoulder was almost invariably due to restriction of abduction and outward rotation. Complete abduction with outward rotation was therefore the attitude of election during the primary period of repair, the means employed to assure it being of less importance.

HÆMOLYTIC STREPTOCOCCUS GANGRENE OF ARM AND FOREARM

DR. HENRY H. M. LYLE presented a man who entered St. Luke's Hospital, March 15, 1924, with a diagnosis of superficial gangrene of the arm. He was profoundly septic and presented an extensive superficial gangrenous inflammation of the right arm. The inflammation involved the flexor surface of the arm from the hand to within one inch of the axilla and was chiefly confined to the subcutaneous and fascial tissues. The accompanying illustrations show the nature and extent of the lesion (Fig. 1).

Operation, March 15, 1924. Complete débridement of all the involved tissues with implantation of Carrel tubes.

The patient was in such a desperate condition that it was thought to be advisable to operate without any general anæsthetic; local anæsthesia could not be employed on account of the extent and conditions present. Experience in France had shown that such cases were not very sensitive, due to the fact that the superficial sensory nerves were destroyed or their conductivity diminished by the inflammation. The whole right arm was swollen to about two and a half times its normal size. The hand was very œdematous. The whole flexor surface of the arm was involved in a process which seemed to have caused necrosis and sloughing of the skin, superficial fat and some of the fascia. Flaps of skin were undermined with pussy material suggestive of carbuncle. The intermuscular fascial septa were in some places eaten away and pus exuded from between the muscles. The skin was red and somewhat macerated. Skin on shoulder and back was puffy and red.

Operative Procedure.—Without anæsthetic, sloughs were cut away from the flexor surface of the arm. Little strips of relatively uninvolved skin were severed and undermining slough removed. Pus pockets between the muscles were opened and the whole raw area was washed with peroxide and Dakin's solution. Four Dakin's tubes were applied under the flaps of skin and between the muscular septa. Posterior part of the arm was not treated, as it could not be definitely ascertained whether or not it was involved in the sloughing process.

These cases were not infrequently encountered in the fall of 1916 and their prevalence in some sections were largely due to the unhygienic conditions following the battle of the Somme. In the last year he had had three similar

FIG. 1.—Hæmolytic streptococcus gangrene. March 15, 1924. Point of entrance of infection, tip of little finger.

cases in his service at St. Luke's Hospital; one late case which involved the entire leg required an amputation just below the hip to save his life, another involving the penis and scrotum died.

Meleney believes that the characteristic lesions are caused by a special strain of hæmolytic streptococcus which possesses an active lipolytic ferment.

The best plan of treatment is an early thorough débridement of the involved superficial structures, a sterilization of the wound by the Carrel methods, and prompt employment of Thiersch skin grafts.

An excellent article on this subject has been written by Meleney, "Hæmolytic Streptococcus Gangrene," *Arch. of Surg.*, vol. ix, No. 2, Sept. 24, p. 317.

DR. FRANK MELENEY (by invitation) said that the case presented a very interesting condition which is apparently rare in this country but rather common among the Chinese. During the last four years he has seen about 35 cases in the Peking Union Medical College Hospital in Peking, China. The lesion occurs most often on the extremities, but it may develop on any part of the body surface. He has seen it affecting the scrotum and penis, the abdominal wall, the chest wall, the breast, the neck and the face. Recently a Chinese patient has entered the Presbyterian Hospital with this lesion on the scalp. Apparently it is a clear-cut clinical entity. It starts from any small break in the skin and spreads with alarming rapidity in the first two days.

Then it causes an extensive necrosis of the subcutaneous tissues and seems to localize. Secondarily, but with considerable rapidity, there is death of part of the overlying skin. It is essentially a superficial infection and does not invade muscle or bone unless the original injury involves those tissues. Most of the cases recover following extensive incisions and removal of the gangrenous tissue. One would suspect the presence of anaërobic organisms, but they are not found in this lesion. The only organism which is constantly present is the hæmolytic streptococcus which is found in pure culture in most of the cases. The lesion differs from the usual types of streptococcus infection by destroying a large mass of tissue and by tending to localize after its

FIG. 2.—The condition of hand and arm April 27, 1924. Result from débridement, Carrel treatment and Theirsch skin grafting.

initial rapid spread. This must be due either to some peculiar biologic activity on the part of the organism or to a peculiar lack of local resistance on the part of the patient. Efforts have been made to determine whether or not the organisms recovered from this type of case had some special characteristics which would classify them in a special biologic group. The ordinary cultural tests have revealed nothing. Tests made to determine their lipolytic activity have failed to show any strongly active lipolytic ferment which might explain their localization in the subcutaneous fat. Agglutination experiments so far have not proved satisfactory but further efforts are being made in this direction. If cases are occurring in this city from time to time, Doctor Meleney said that he would like very much to obtain some cultures of the infecting organisms.

ARTERIOVENOUS ANEURISM

DR. HENRY H. M. LYLE presented two patients.

CASE I.—A man, aged twenty-five years, entered St. Luke's Hospital, November 27, 1924, with a diagnosis of osteomyelitis of left tibia and fibula, arteriovenous aneurism of the right popliteal space, multiple foreign bodies.

He was wounded during the battle of the Somme in 1916, receiving a perforating shell wound of the lower third of the left leg and numerous small wounds of both legs. Three days later gas gangrene appeared in the left

leg and spread rapidly. Three general operations with multiple incisions were performed before the gangrene was checked—six months later he was operated on for osteomyelitis of the left tibia—the wound remaining open five months. Two years later the wound broke down and has been opening and closing ever since. Within the last few months the patient has noticed that his right leg and foot have been swelling and that there is some weakness of the right knee, no pain.

Examination shows a chronic ulceration of the inner aspect of the left tibia about one and one-half inches above the ankle-joint. There are numerous vertical scars throughout the leg. The ankle is stiff and the foot swollen. The right leg and foot is larger than the left, there are a number of dilated veins. In the right popliteal space there is a pulsating swelling about the size of a small mandrin. X-ray examination of the left leg shows the presence of an old fracture with osteomyelitis and numerous small shell fragments. Examination of the right knee discloses several small shell fragments and the suggestion of a tumor formation.

Operation, November 11, 1924.—Obliterative endo-aneurismorrhaphy for arteriovenous aneurism of right popliteal space.

Pathological Findings.—There was a fistulous communication between the right popliteal artery and vein, resulting in a fusiform dilatation of the artery and dilatation and tortuosity of the vein. The lumen of the artery was coated with laminated clots. The opening in the vein ran downward and outward and then curved back on itself for a short ways. The arteriovenous aneurism was of the direct or aneurismal varix type.

Operative Procedure.—A linear incision was made in the popliteal space going down through the skin and subcutaneous tissues, exposing the popliteal vessels, which were carefully dissected free from the surrounding tissues. An Esmarch bandage had previously been applied so as to render the field bloodless. The vein was opened for about 3 cm., its lumen explored for the fistulous orifice; such openings as were presented appeared to be collaterals of the vein. It was then decided to open the artery which was done by means of an incision 2 cm. in length. The blood clot was removed, and the fistulous opening discovered at the lower portion of the artery just below the incision. It was then probed and the fistula found to take the direction as described above. The opening on the venous side was obliterated by interrupted sutures of silk and chromic catgut. The lumen of the vein was then obliterated by plication sutures of silk and double 0 chromic. The opening on the anterior side was closed by a purse-string suture of silk and the lumen of the artery was then obliterated by plication sutures. The Esmarch bandage and the tourniquet were removed, all bleeding vessels carefully ligated. The distal portion of the vein was much dilated and distended with blood, but bleeding was readily controlled. The deep fascia was approximated with sutures of chromic catgut. The subcutaneous suture was placed and the skin closed with interrupted sutures of silk. The tourniquet was on for an hour and a half.

Examination of the specimen showed the sac wall to contain several small shell fragments.

Case II.—A soldier in the 77th Division received a shell wound of the right leg, June 3, 1918. He entered Evacuation Hospital No. 2, where a diagnosis of compound fracture of both bones was made. The wound was débrided and the shell fragments and clothing removed and the leg treated by the suspension and traction. During the night he suffered a severe secondary hemorrhage which required operative interference to check. The wound

drained for a period of six weeks. The patient wore a Thomas splint for one and one-half years. In 1922, he noticed a swelling on the inner side of the right foot; this broke down and discharged pus for three months. In October, 1924, there was a recurrence of the above symptoms. December, 1924, he was examined at the Veterans' Bureau and found to have an arteriovenous aneurism of the lower third of the inner aspect of the right leg. The dorsal veins of the foot were swollen and showed a visible pulsation. He entered St. Luke's Hospital, December 6, 1924, almost four and one-half years after the original injury.

X-ray Examination December 8, 1924.—There is an oval swelling on the right tibia at the junction of the middle with the lower third which has the characteristic appearance of an old osteomyelitis. The inner border is very ragged, possibly as a result of operative interference, and surrounding this area are numerous, dense foreign bodies. There is a similar foreign body on the inner side of the bones of the foot.

The aneurism cannot be made out in the röntgenograms.

Operation December 9, 1924.—Arteriovenous aneurism of the posterior tibial of the right leg. Obliterative endo-aneurismorrhaphy.

Pathological Findings.—There was an arteriovenous aneurism in the anterio-internal aspect of the right leg, about the level of the aneurismal varix or the direct type. The sac was about 2 cm. in diameter, occupying a position close to the bone and had rounded out a smooth concavity in the bone for itself. That portion of the sac attached to the bone was quite adherent. About five or six venules communicated with the sac. There were areas of calcification involving the intima of the sac and around the periphery of the sac were numerous small black foreign bodies, some consisting of shell fragments and one or two of shreds of clothing. The veins, distal to the sac, were tortuous and dilated. When the sac was obliterated there was no pulsation in the veins of the internal side of the foot; nor was there a bruit present. However, there was a distinct pulsation in the region of the posterior tibial artery as it passed around the internal malleolus. There were several large adherent scars over the anterior and internal side of the leg, the result of previous osteomyelitis. Examination of the specimen showed the sac wall to contain numerous small shell fragments.

Operative Procedure.—An incision was made over the pulsating area at the junction of the middle and lower thirds of the leg, exposing the dilated veins. The dissection then carried down to the bone and the aneurismal sac located. In attempting to dissect the sac off the bone, the wall was punctured so that the sac was then laid bare for some distance. The sac was further dissected away from the surrounding tissues above and below and the communicating venules tied off. At this junction the tourniquet was released and a moderate degree of venous hemorrhage occurred which was controlled by means of ligatures. Several dilated varicose veins were removed and the subcutaneous tissues and deep fascia were then closed over the posterior tibial nerve which had been exposed during the dissection. The skin then closed with a right angle suture of silk, after a large scar was dissected off the bone. An incision then made over the internal side of the foot exposing one of the large dilated veins, which was divided between ligatures and the incision closed.

The interesting points in these cases are the delay in the development of the aneurisms and the presence of small shell fragments in the sac walls. The irritation of the small sharp shell fragments has been a factor in the

causation of these lesions and this must be kept in mind in dealing with such cases. The records show that aneurisms with these findings are occurring much more frequently than had been supposed.

SEPTIC ARTHRITIS OF KNEE

Dr. Charles E. Farr presented a child who at four and one-half years of age, entered the New York Hospital, service of Doctor Gibson, March 11, 1925, and was discharged cured March 31, 1925. Ten days before admission the child was alleged to have hit her right knee with a pin. That night the knee became red, swollen, and tender. The family physician told them to use cold applications. Three days later a blood culture was taken showing staphylococcus aureus. An X-ray was also taken, but it showed no bone involvement. On admission the child's right knee and thigh were greatly enlarged, brawny, red and extremely tender. Motions were almost completely lost. The temperature was 103, pulse 130. The leucocytes were 27,000 with 87 per cent. polymorphonuclears. The red cells were 2,880,000 with 50 per cent. hæmoglobin. The blood culture was negative. The child was operated upon at once, using long lateral incisions, and opening the knee-joint widely. A large amount of thick pus was evacuated from the knee-joint and from a huge pocket beneath the vastus externus extending half-way up the femur. No drain was used. A small, moist dressing was applied. The wound culture showed streptococcus hæmolyticus.

Every endeavor was made to induce the child to use the knee, but this is always extremely difficult in little children. The procedure adopted was to tickle the child's sole at frequent intervals. This caused voluntary flexion. The foot was then grasped and traction gently applied until the leg was nearly straight. In this way the desired motion of the joint was obtained without trauma. On the seventh day, at the suggestion of Doctor Gibson, the child was allowed up and encouraged to walk. Drainage from the knee-joint had practically ceased. On the fourteenth day 50 per cent. motion was present and the wounds were healed to superficial granulating sinuses. The temperature and pulse dropped rapidly after operation and the child has made an uninterrupted recovery. At the present time, April 22, six weeks after operation, the wounds are nearly healed and motion is 75 per cent. of normal. X-rays taken a week after operation showed no involvement of the bone.

Comment.—This was a savage infection of the knee-joint and of the intra-muscular planes of the thigh. The child was desperately ill. The treatment and outcome illustrate well the great advantage of the Willems treatment.

STRANGULATED FEMORAL HERNIA, AND SLIDING HERNIA OF THE BLADDER IN A CHILD

Dr. Charles E. Farr presented a boy, who, at ten years of age, entered New York Hospital, April 5, 1925, in the service of Doctor Gibson. His chief complaint was of a mass in the right groin, with vomiting and diarrhœa. The mass had been present only a few hours. Physical examination showed an ovoid mass 2 by 1 inch in the right groin and slightly below the inguinal ligament, evidently a strangulated femoral hernia. The boy's general condition was excellent. There was no bladder symptoms. His past history indicated a poliomyelitis in infancy affecting the abdominal muscles, and the muscles of the right thigh and leg. He has had an operation on the right ankle in another hospital.

January, 1925, he entered New York Hospital and was operated upon for a weakness in the right groin which proved to be a bulge in the direct triangle without an actual hernial sac. At this time the physical examination showed a soft irreducible swelling below the inguinal ligament and about one-half inch in diameter.

At operation on the second admission the usual vertical incision was made. A typical femoral hernia sac was developed and opened. It contained a strangulated loop of ileum which was observed for a few moments, found to regain its color and reduced with some difficulty, after nicking Cooper's ligament. The sac was then dissected high up in the femoral canal. The fat in the thigh surrounding the femoral opening had a peculiar appearance and bled more than usual. It was dissected up and found to contain a large portion of the urinary bladder, extending out of the canal into the thigh internally, posteriorly, and slightly externally to the sac of the true hernia. The bladder was freed in all directions widely, the bleeding carefully controlled, and the mass was then reduced with ease inside the abdominal cavity. The hernial sac was then doubly ligated and cut away. The inguinal ligament was sutured to the pectineal muscle and fascia with interrupted chromic catgut. The wound was closed in the usual manner and healed by primary union. Convalescence was uneventful.

Comment.—Beyond reasonable doubt the sliding hernia of the bladder was present at the time of the original operation, and was overlooked, as was the small femoral sac. Sliding hernias of the bladder into the femoral space are uncommon, but probably not extremely rare. The unusual feature in this case was the lack of bladder symptoms or abnormal urinary findings at any time, either before or after operation.

SPLENIC ANÆMIA, COMPLICATED BY LUNG ABSCESS

Dr. Charles E. Farr presented a little girl, who at five years of age, entered St. Mary's Free Hospital for Children, September 27, 1923. For the previous two years she had had frequent attacks of fever, headache and malaise, lasting three days to a week. The present illness came on suddenly September 23, 1923, with headache, fever, malaise, pain in the abdomen, diarrhœa and frequent urination. She had been coughing a day. She had been in the hospital, January, 1923, for an infected vaccination, and again in February, 1923, when a diagnosis of acute catarrhal jaundice was made, but she was sent home the next day with a positive diphtheritic throat.

Physical examination showed a child with a typical lobar pneumonia involving the left lower lobe. There was no râles at this time. The abdomen was prominent and soft. The liver was five fingers below the costal margin. The spleen was palpable below the costal margin. The extremities were normal. The skin and the scleræ were icteric. Her temperature was 103-8/10. Signs of fluid in the left chest were obtained October 4, 1923, and the chest was aspirated three times and then a thoracotomy performed October 12, 1923. From time to time thereafter the wounds were enlarged and the thorax explored because of lack of good clinical progress.

She came under Doctor Farr's care, February 1, 1924. Examination at this time showed an anæmic, jaundiced, frail child whose left chest was discharging freely. A lung abscess was detected by X-ray. The liver and spleen were moderately large. There was some fluid in the abdomen. On February 2, 1924, the blood count showed hæmoglobin 55 per cent., red cells 2,180,000. Repeated transfusions were done with temporary benefit. Finally the thorax was thoroughly opened and the lung compressed against the

mediastinum with vaseline gauze packs and rubber drain. Healing of the lung abscess occurred fairly promptly and a large clean granulating wound obtained. The bleeding time was five minutes and the coagulating time was ten minutes. Differential count showed Turck's cells and a few myelocytes, with anisocytosis, poikilocytosis and achromia. In April, the hæmoglobin had risen to 60 per cent., the red cells were 3,904,000. There was considerable bloody oozing from the nares and from the wound.

On May 2, 1924, a splenectomy was performed with the usual technic. The spleen was about three times normal size. The surface was irregular. The liver was moderately enlarged, very nodular and rough. A moderate amount of bloody fluid was in the abdomen. On May 12, the entire wound separated, although there was no infection. It was re-sutured with success. The hæmoglobin and red cells fell moderately, but there was at this time no abnormal cells and slight poikilocytosis. In June, the hæmoglobin reached 58 per cent., and red cells 3,584,000. There was a considerable effusion in the abdomen during the summer, but the child improved with country treatment. She received one more transfusion. The effusion was absorbed and her general health was fairly good. The jaundice had cleared up, but the liver was palpable. Both wounds were firmly healed.

Microscopic examination of the spleen was not typical of Banti's disease, although the clinical picture was quite characteristic. Wassermann tests of the child and parents had been negative throughout. The pathologist, Dr. William Clark, reports as follows: "Splenic corpuscles were reduced in number, the sinuses were dilated, the connective tissue œdematous. There was no increase in fibrous connective tissue. A second section showed connective tissue infiltrated with polymorphonuclear leucocytes." The pathologists suggested some kind of purpura. The urine showed bile at intervals and occasional red blood-cells, constant albumen and occasional casts.

In December, 1924, the child returned to the hospital with pronounced jaundice, fever, vomiting, epistaxis. Her blood count at this time showed hæmoglobin 45 per cent. A transfusion was performed and she received Alpine Lamp treatment every second day. Improvement was rapid and has been continuous since. The child is now in fairly good general health but cannot be considered cured.

Comment.—Clinically this was a typical case of Banti's disease with the incidental bleeding common to this disease. Doctor Clark, after mature consideration of the history and the pathological specimen, is still firmly under the conviction that the condition was purpura. It would seem under the circumstances that the clinical diagnosis is probably correct.

Dr. Edward W. Peterson said he had a patient with severe anæmia who had a very large spleen and liver. Splenectomy was followed by marked improvement for a time, but the hemorrhages again recurred, the anæmia became more pronounced and the child succumbed in spite of blood transfusions.

Dr. Eugene H. Pool said it is difficult to classify these cases. Many consider that splenic anæmia is really an early stage of Banti's disease; that if the disease progresses, cirrhosis and ascites will develop, the terminal stage being called Banti's disease. Numerous cases of splenic anæmia have been followed for many years after splenectomy with apparent cure; the speaker had a case which he had followed for about ten years and the patient continued in good condition.

DOCTOR FARR, in closing the discussion, said that these cases are much improved by splenectomy even in fairly late stages. If they can be operated on early, one can count on a cure.

FRACTURE OF THE HARD PALATE

DR. CHARLES E. FARR presented two patients.

CASE I.—A boy, nine years of age, entered St. Mary's Free Hospital for Children, March 7, 1925, and was discharged March 29, 1925. One hour previously he had been knocked down by a taxicab. He was not unconscious, was bleeding from the mouth and nose and was somewhat stuporous. Examination showed a fracture of the right mandible near the front, a laceration of the chin, many contusions, a possible fracture of of the left orbital plate, loss of five upper front teeth. The hard palate was split for a distance of about two inches in midline beginning with the alveolus and extending backward to the junction with the soft palate. The eyelids were much discolored and swollen. There was a swelling of the right mandibular joint. He was in considerable shock. His nose was full of blood. His pupils were equal, dilated, and reacted sluggishly to light. His right middle ear contained blood behind the drum. His reflexes were normal except for an exaggeration of the knee jerks. His pulse was 70 and his temperature was 99. He made an uninterrupted recovery, although his temperature rose to 102-2/10, and the pulse to 120, and he was drowsy and irritable at intervals. The discoloration of the eyelids increased and then diminished. Examination of the eye-grounds by Doctor Cutler on the fourteenth day under homatropin showed both optic nerves slightly paler than normal with normal retina and vessels. There was also slight increased resistance of the right orbit on pressure downwards and backwards. March 15 it was noted that the cleft in the palate was covered with granulations. March 22, slight asymmetry of the face noted. The right palpebral fissure was widened, and the palate was healed.

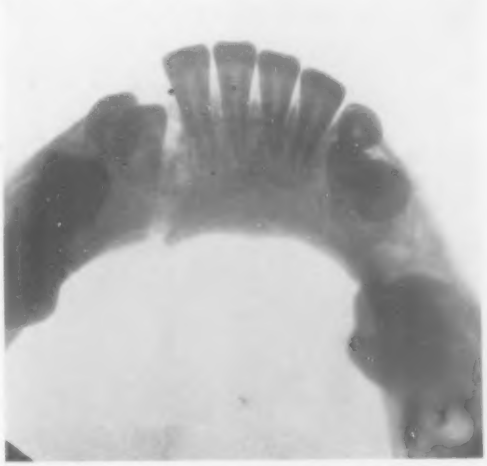

FIG. 3.—The fractured mandible in Case I.

FIG. 4.—The fractured hard palate in Case I.

In these automobile cases it is usually impossible to tell how the violence produced the fracture. It would seem probable that he received a sharp blow on the chin chiefly upwards, forcibly separating the hard palate by impact against the upper teeth.

The technical difficulty of showing these fractures of the palate, and those of the anterior portion of the mandible was overcome by use of a large dental film within the mouth.

CASE II.—A boy, eight years of age, entered St. Mary's Free Hospital for Children, March 16, 1925, and was discharged April 25, 1925. One hour previously he had been knocked down by a taxicab. He was conscious, and bleeding from the nose, which was fractured. There was marked swelling and discoloration of both lids. The pupils were equal and reacted to light. There was no strabismus and his ears were normal. There was a doubtful fracture of the mandible near the front. The hard palate was open for a distance of one inch just back of the alveolus. There was free bleeding from this, and from the nose, and a profuse watery discharge presumably from a fracture of the cribriform plate. There was a fracture of the cuboid, and the first and second metatarsals. There was a left knee and ankle clonus but no Babinski. He was in moderate shock. His temperature rose to 102-6/10, and pulse to 124, but soon subsided to normal. There was an infection of the left maxillary sinus which was drained through an opening beneath the upper lip. There was also a free purulent discharge from the nose. The spinal fluid remained clear but contained five leucocytes and many red blood-cells. The Noguchi test was positive. A culture and smear of the antrum pus showed mixed streptococcus and staphylococcus. On March 19 there was a suggestive left Babinski. X-ray showed an apparent fracture of the posterior portion of the right temporal bone. March 21, there was slight internal strabismus not present before injury. Eye-grounds were negative. The boy made an uninterrupted recovery and is now perfectly well.

FIG. 5.—Fracture of the hard palate in Case II.

Comment.—This is the second case of fracture or separation of the superior maxillæ within a fortnight. As in the preceding case the application of the force which caused the fracture is in doubt, but presumably it was from below upwards by means of the mandible.

UNILATERAL FUSED KIDNEY

DR. CHARLES E. FARR presented a colored boy, two years of age, on whom he operated in St. Mary's Free Hospital for Children, March 20, 1925, for umbilical hernia of large size. There was no history of anything abnormal except the hernia. During the course of the operation the abdomen was explored, the left kidney found missing from its usual bed and two kidneys palpated on the right side, one of about normal size, and slightly lower than normal position, the other just on the pelvic brim about normal in size but

irregular in shape. The two were joined by a thick band apparently of renal tissue about one inch in width (Fig. 6).

The child made an uninterrupted recovery from the operation and has given no signs or symptoms of his renal abnormality. There is an occasional leucocyte and some epithelium in his urine with amorphous urates. The diagnosis of fused kidney is rarely made except by pyelography. Even more rarely the condition is found incidently on operation as in this case. The importance of its recognition is obvious. Unless infection, calculus, or tuberculosis develop, or an unwarranted surgical attack is made, these fused kidneys are compatible with long life and good health.

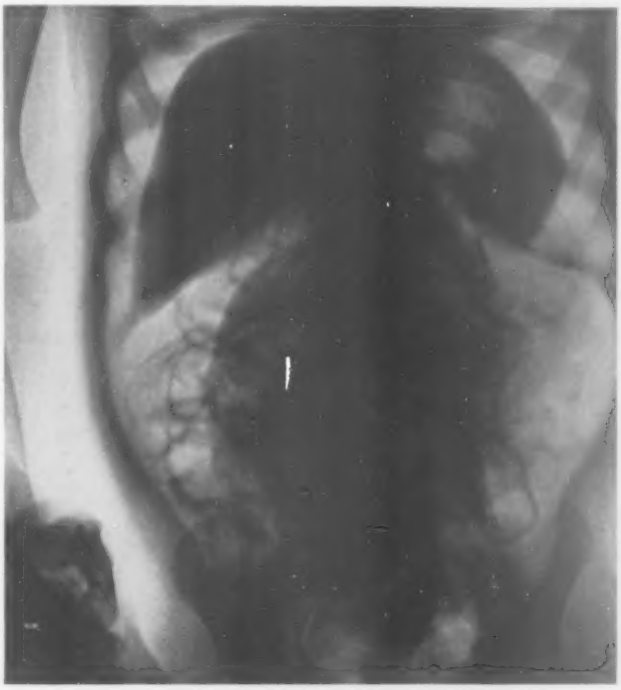

FIG. 6.—Unilateral fused kidney (right) pneumoperitoneum.

DR. EUGENE H. POOL said that some years ago he had a case which he operated for calculi in the left kidney and discovered a horseshoe kidney, the two kidneys being fused. There were numerous large calculi present in what corresponded to the left kidney and that portion of the kidney was resected. The patient still has a urinary fistula.

BENIGN TUMOR OF THE STOMACH

DR. CHARLES E. FARR presented a man, who at sixty years of age, entered the New York Hospital, private pavilion, July 11, 1924, and left July 27, 1924. His chief complaint was weakness and distress in the chest and abdomen. His history dates back about one year when he had an attack of influenza. His pain was irregular and was relieved by soda, or simply by pressure. His weakness had been progressive, and he also suffered from high blood-pressure and Bright's, with dyspnœa on exertion, and anginal attacks. Previous to admission he had been under the care of Doctor Keays and Dr. Herman Mosenthal, who had diagnosed a benign tumor of the stomach basing this on the duration without cachexia. There was occult blood in the stools and the X-ray showed a movable shadow in the central portion of the stomach, apparently a polyp (Fig. 7). There was no marked loss of weight.

On admission to the hospital the hæmoglobin was 40 per cent., red cells 2,500,000, the leucocytes 6500 with 60 per cent. polymorphonuclears. He was operated upon July 14 under colonic oil ether anæsthesia. A pedunculated mass nearly 6 cm. in diameter was found on the posterior wall about the middle of the stomach. Gastrotomy allowed an easy delivery of the mass.

The pedicle was clamped and the tumor removed. The base was cauterized and whipped over with chromic catgut, the gastric and abdominal wounds were then closed in the customary manner. He made an uninterrupted recovery. His highest temperature was 100-8/10 and pulse 90. July 23, his hæmoglobin had risen to 52 per cent. Improvement was continuous but slow during the summer. In September, 1924, he suffered an attack of acute volvulus from which he recovered spontaneously just as he was about to be operated upon. His hæmoglobin is now 80 per cent., his general strength better, but he still suffers from the original cardiac and arteriosclerotic symptoms with angina. He is able to get about and attend to his business, has gained much weight, has no gastric symptoms and no occult blood.

FIG. 7.—Benign tumor of the stomach.

The pathological report is as follows:

"Papilloma of stomach. Specimen (Fig. 8) consists of an oval pedunculated villous tumor 6 x 4 x 4 cm., soft, covered with villi which are about 1 cm. in height and vary from 2 to 5 mm. in diameter. The base which is not indurated is 25 mm. in diameter.

"Microscopic examination (Fig. 9) of material from several portions of the growth and of the base shows no definite evidence of malignancy. There is no invasion of the subjacent structures, although in places there is evidence of very active proliferation leading to a piling up of cells which, however, are still fairly well oriented. The tumor can be ranked as a papilloma of the stomach, although it must be borne in mind that these tumors are prone to undergo malignant transformation. As a rule this occurs very late after it has assumed large proportions. Since only a relatively small portion of the growth can be examined microscopically, it is not possible to absolutely exclude such an occurrence in any instance and this should be considered in rendering a prognosis."

Comments.—The unusual feature in this case is the almost complete absence of stomach symptoms which were simulated in a way by the anginal attacks. The tentative diagnosis of benign tumor of the stomach was founded on reasonably good evidence. The post-operative recovery has been very satisfactory. A similar but larger pedunculated growth in a much younger

man, also practically symptomless except for silent bleeding, was found to be malignant, requiring the resection of about four-fifths of the stomach. It is questionable whether such radical resection is justified in a pedunculated growth without metastases, particularly where the situation of the growth necessitates a difficult technical procedure.

FIG. 8.—Papilloma of stomach, after removal.

CARCINOMA OF THE CLITORIS

DR. JOHN C. A. GERSTER presented a case of carcinoma of the clitoris with bilateral excision of inguinal lymph-nodes one year after operation. The patient was a woman of fifty-six, who was admitted to the Fifth Avenue Hospital, March 13, 1924. Her mother died of cancer; her father of dropsy. Had been married for some thirty years. Had several miscarriages but never any full-term pregnancies. She suffered from rheumatism in her legs for some years past, otherwise well.

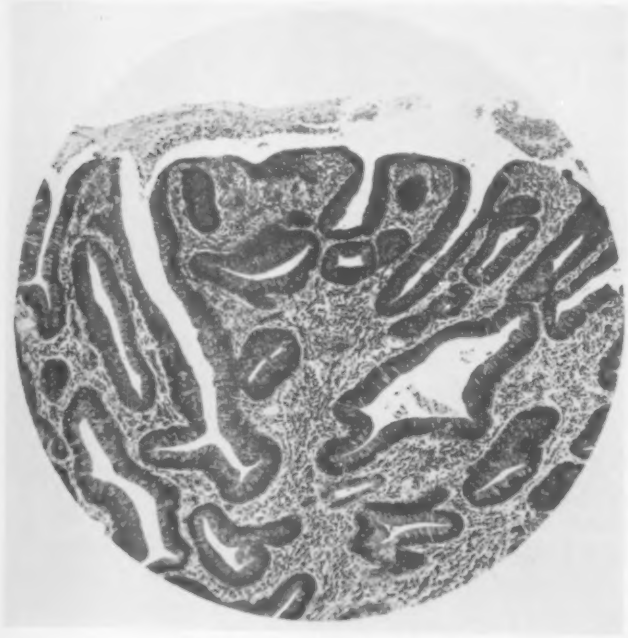

FIG. 9.—Papilloma of stomach.

One year ago she noticed a painless lump in both groins, the right larger than the left. Also a mass in the vagina, which was tender and bled easily.

On physical examination the patient proved to be an obese woman in fair condition, whose general physical condition revealed nothing abnormal considering her weight and age. Locally there was a tumor the size of a cherry involving the distal half of the clitoris, tender and ulcerated. There were hard painless masses in both inguinal regions 3 x 4 c.c. in extent on the left and 2 x 6 c.c. on the right.

March 13, under ½ per cent. novocain anæsthesia, a wide excision of the clitoris and its adjacent tissues down to the symphysis pubis was made with an electric cautery knife. The following day, under local anæsthesia, a block dissection of the right inguinal region with extirpation of nodes and parts *en masse* down to deep fascia was made. This included stripping of subcutaneous fat from inguinal region to vulva. March 15 a similar excision under local anæsthesia was performed on the left side. Naturally the wounds were mildly infected but she made an uneventful recovery and was discharged April 6, 1924. On the twenty-fourth day after the first operation. Since then she has received radio therapeutic treatment at St. Luke's Hospital.

A few weeks ago a tender swelling was noted in the left major labium. An abscess formed, opened spontaneously, and the mass disappeared. Several similar tender masses are now present in the right side of the mons veneris apparently inflammatory in character. There is some erythema of the skin in both inguinal regions, but so far no signs of recurrence. She has not lost weight. Microscopical examination by Dr. S. D. Jessup, pathologist of the Fifth Avenue Hospital, showed a prickle-cell epithelioma of the clitoris with secondary deposits in both masses of inguinal nodes at their centres. The outlying nodes showed congestion and hyperplasia.

CLINICAL CONSIDERATIONS OF THROMBOSIS AND EMBOLISM

Dr. John A. Vietor read a paper with the above title, for which see August Annals of Surgery, vol. lxxxii, p. 193.

Dr. Willy Meyer said that it was now generally accepted that Aschoff's theory is likely correct, that due to microörganisms floating in the blood, inflammatory deposits and thrombus formation, occurred in such vessels of the venous system, where the blood stream is slowing up. It is usually the left femoral vein that is involved, and the theory of the slowing of the blood stream just underneath Poupart's ligament is well supported by anatomical facts. If we place the patient in a position, in which this portion of the blood stream is accelerated, we are observing a prophylactic point. Since Doctor Meyer had placed the patients operated upon in a slight Trendelenburg's posture he had not seen any thrombosis of the left femoral vein. We are living in a prophylactic age; every physician and surgeon should try to avoid possible trouble. Whoever has had one of these cases of post-operative femoral thrombosis under his care would, he was sure, never forget it on account of the annoyance caused to the patient and himself.

Regarding embolism, there is a difference between embolism of an artery of an extremity and pulmonary embolism. Every busy surgeon had seen cases in which after a chronic endocarditis suddenly the brachial or iliac or femoral artery became plugged. These are most important cases. If the embolus could be localized and the patient able to stand an operation, cutting down onto and into the artery and removing the embolized thrombus and then sewing up artery and wound is the ideal procedure. If the exact place cannot be diagnosed, regular and prolonged baths of superheated air, immediately started, could prevent gangrene.

A word on pulmonary embolism. Many patients die immediately from shock, others in three to five minutes. It has been stated in the literature that about one-half of the severe type live from ten to sixteen minutes. It was based on careful observation and experimentation when Trendelenburg sixteen years ago proposed to extract pulmonary emboli. Members of the staff and nurses must be trained and everything be ready for the operation; the assistants must know how to proceed because there are just the ten to fifteen minutes time in which the patient may be saved. Twelve years ago Doctor Meyer had tried the operation on dogs. He could show one dog who had recovered before the Surgical Society. The work must be done with the help of differential pressure and oxygen. It was the crowning point of Trendelenburg's life that when he attended the meeting of the German Surgical Congress in 1924, Kirschner, of the University of Koenigsburg, was showing a patient who had recovered from this operation which had been carried out in every detail according to the rules laid down by Trendelenburg. With one patient recovered and a record of a few who have lived three, four and five days after the operation, pneumonia having been the usual cause of death, the time seems to have come when one should not wait to see what will become of these patients, although a very small percentage will recover spontaneously. Every hospital should be prepared to do Trendelenburg's operation; but it is necessary, as said before, that assistants and nurses are trained to recognize immediately when a pulmonary embolism has happened. An attempt should be made to save these patients as most of them are lost if not operated on. Trendelenburg advised to compress pulmonary artery and aorta with an elastic tube. Then only 45 seconds are at the disposal of the operator to extract the emboli. The right heart is always distended to the utmost capacity. Incision of the pulmonary artery brings immediate relief. It has been found if the superior and inferior vena cava are compressed, eight to ten minutes are at the disposal of the operator. If the assistant compresses these two veins the surgeon can extract the emboli with more leisure and a greater number of these patients may likely recover.

Dr. Walton Martin spoke of a patient who was operated on for appendicitis and recovered and during the second week had a pulmonary embolism. He was given quantities of morphine and the pain passed off and his life was saved. This same treatment was given to another patient who had been operated on for carcinoma and developed signs of pulmonary embolism and recovery also occurred in this case. He died one month afterward and at autopsy the plug in the artery could be seen. This is a reflex condition which kills and it is worth while bearing in mind.

Dr. John A. Hartwell said that he had been a victim of pulmonary embolism. He could confirm Doctor Blake's description. The one thing he desired was morphine, which he preferred to an operation on the pulmonary artery.

Dr. William B. Coley stated that, in his experience, embolism following operation for hernia had been extremely rare. In 1918, in a report of 8589 cases of hernia treated by radical operation from 1891 to 1918 (by Coley and Hoguet) not a single case of embolism was noted. At the Mayo Clinic from 1899 to 1911, five per cent. of the total number of deaths following major abdominal operations were due to post-operative embolism.

Dr. Burton J. Lee said that bearing on the question of infection it is interesting to note that a head nurse working in a New York Hospital has frequently predicted that a case might develop pulmonary embolism and upon three occasions has been correct in the prediction. The suggestive symptoms had been a slight temperature, associated with some general malaise and indefinite abdominal discomfort. Following these observations, the speaker had kept close watch upon his patients and had found that quite routinely a slight temperature rise had appeared before embolism had occurred.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held May 8, 1925

The President, Dr. Edward B. Hodge, in the Chair

CYST OF THYROGLOSSAL DUCT

Dr. Jessie W. Pryor presented a man, aged twenty-seven years, who was admitted to hospital complaining of a swelling in his neck. This mass was first noticed five years ago, when it was the size of a pigeon's egg; it has been growing slowly until it now in size and shape is equal to a hen's egg. The mass lies just to the right of the midline in the upper part of the neck. (See Fig. 1.) It extends to the midline, but does not cross it. It is freely movable, circumscribed, soft, no fluctuation obtained and no pulsation or bruit. On swallowing, the mass is definitely elevated and quickly descends as though attached to the base of the tongue.

The mass was a little too high to be a cyst of the right lobe of the thyroid. The man came to operation with three diagnoses suggested by three people: (1) Branchial cyst. (2) Lipoma. (3) Cyst of thyroglossal duct.

The definite attachment to the base of the tongue caused the reporter to stick to the thyroglossal idea even although the mass was definitely on the right side and not in the midline.

Fig. 1.—Thyroglossal cyst, anterior view.

A collar incision was made in the crease of the neck through skin and platysma, crossing from the anterior border of one sterno-mastoid muscle to the anterior border of the other. The flaps were retracted up and down. The pretracheal fascia was then incised vertically and dissecting with finger and scissors a mass, the size of an egg, was freed on each side and posteriorly. The appearance of the cyst at this stage was fusiform, the upper pole was very definitely attached to the lower border of hyoid bone and the lower pole attached to upper margin of the right lobe of the thyroid.

About this stage the cyst was ruptured. It contained opaque yellowish semi-gelatinous fluid. The cyst wall was then ligated at the attachment to thyroid gland and as close to the hyoid bone as possible. The bands were cut, the pretracheal fascia closed, the platysma sutured and the skin wound closed. The recovery was uneventful.

Pathologist's Report.—The specimen consists of the wall of a cyst about the size of an almond, having a ragged lining and smooth outer surface. Externally it is attached to an elongated mass of tissue about an inch long, apparently the wall of the thyroglossal duct.

Microscopic Description.—a. The wall consists of a dense sclerotic fibrous tissue containing masses of colloid inclosed in the interstices and in what appear to be dilated luminæ.

b. Fibrous tissue structure surmounted by laminated wall, containing a system of capillaries filled with red cells, and having a homogeneous free surface. At one end is a portion of the same structure seen in colloid masses. Diagnosis: Cyst of thyroglossal duct.

RHINOPLASTY FOR SYPHILITIC DEFECT OF NOSE

Dr. Robert H. Ivy exhibited two cases of total rhinoplasty for syphilitic defect of the nose, in which the Indian flap method, as modified by V. P. Blair, was used. A single flap is employed to form the entire external nose, its distal end being folded to form columella and lining for alæ. These cases demonstrate conclusively that by this method sufficient prominence of the lower part of the nose can usually be obtained without the use of cartilage or other supporting tissue in this region. Cartilage is only implanted in these cases where the nasal bones themselves give no prominence to the upper part of the nose, and even here it is not usually necessary. In one of the cases no cartilage whatever was employed. In the other, a small piece of costal cartilage was implanted over the depressed nasal bones, high up beneath the forehead flap.

INTRAPERITONEAL TRANSFUSION FOR MELENA

Dr. J. Ralston Wells reported the history of a male infant, ten months of age, weighing seventeen pounds, who was admitted to hospital, October 11, 1924, on account of persistent voiding of blood per anum. Five weeks ago it first passed bloody bowel movements. Two weeks later the same blood losses occurred. The day before admission its stool was "blackish" in color and very hard. The patient was evidently in distress when passing this stool, as shown by drawing knees up and crying immediately after it. An enema seemed to relieve the pain but the baby became so cold that hot water bottles were necessary for local body application. It vomited twice on this day; no gross blood in vomitus.

When admitted the child looked severely ill and weak, but was in no acute distress. Is very pale, no flushes. Breathing is 72, with sometimes an expiratory grunt; pulse rapid, 160, and thready. Temperature 103° F.–104° F. Is most comfortable lying with right leg drawn up. Resents disturbance. Abdomen slightly distended and moving with respirations. Palpation shows generalized tenderness and resistance, especially marked on whole right side. No palpable masses nor localizing point or points of tenderness. Peristalsis active. Rectal examination gave no additional information. The general physical examination is negative except for the left thorax, which shows a slightly impaired percussion note and slight impaired resonance over the lower lobe posterior. No alteration in breath sounds. No râles. Head, heart, extremities and nervous system negative; negative urine.

Blood.—Hb. 30 per cent.; red blood cells 2,500,000.

Third Day.—Dark stool passed with large clot of blood. No vomiting but along toward evening appeared in a condition simulating collapse and some liquid dark material resembling blood was passed per rectum. Five c.c. of horse serum was given intermuscularly.

Sixth Day.—Condition improving; no more hemorrhages seen. Temperature now around 100°, respiration and pulse in proportion. No cough.

Seventh Day.—Slight hemorrhage. Temperature, pulse and respiration became practically normal at this time. Slight hemorrhages occurred October 23; November 8; December 17; December 27; January 2; January 3; quite copious hemorrhages occurred November 6; December 25. An intraperitoneal transfusion of citrated blood was first given October 19, when 100 c.c. of the blood was injected. At this date the hæmoglobin had fallen to 22 per cent. The proportion of Hb. rapidly rose after this injection until at the end of ten days it marked 55 per cent. After the copious hemorrhage which occurred November 6, it fell again to 20 per cent. Repetition of the intraperitoneal transfusions of 100 c.c. of blood November 20 was followed by the same gradual increase in the hæmoglobin index until by December 12 it reached 60 per cent. After the hemorrhage of December 17 a transfusion was at once resorted to, with again a rapid rise of the Hb. index to 65 per cent. The repeated hemorrhages late in December and during the first week in January, 1925, caused the decision to make an explorative abdominal incision. An X-ray examination had been made December 11, with the report that the plates indicated a marked narrowing of the lumen of the transverse colon for a distance of about three inches near the median portion on the right side, just above umbilicus.

The von Pirquet reaction was slightly positive.

January 7, under ether, a median incision of the abdominal wall was made. A good exposure was obtained. Nothing abnormal was detected, except some enlarged intraperitoneal glands. No free fluid. No indurations or ulcerations seen nor polyps palpated. One hundred c.c. of citrated blood was put into the peritoneal cavity, and the incision closed. The operative recovery was uncomplicated.

The little patient was retained in the hospital for four months longer, slowly improving, but with a gradual fall in the hæmoglobin index. When the child was finally sent home, May 17, it weighed eighteen + pounds, and its Hb. index was 35 per cent.

DR. CALVIN SMYTHE presented a chart which Doctor Sweet and he worked up some five or six years ago when they were making some studies on intra-abdominal absorption. Using the red blood-cells as an indicator in lymph collected from the thoracic duct and watching how quickly it came through. They found that the invariable result was that in 20 to 30 hours they would get lymph which was absolutely colorless, then a faint trace of color and straight on until they got fluid which was similar to venous blood. It could be seen that it contained red blood-cells. On dogs which were afterwards post-mortemed they invariably found the pleural surface of the diaphragm to contain large amounts of blood, as if there had been hemorrhage. Since Superstein and Stanby wrote their paper on intraperitoneal infusion, he had used the method about twenty-five times in the past year and had found it an excellent one, especially in children. It is relatively painless and gives excellent results. One does not get an immediate effect, but it seems to be more lasting than intravenous injection. He had had no trouble with it. Another point in its favor is that one does not have to type the blood. They were able to use a donor in many cases that for the purposes of intravenous

injection would not have been the correct type. In this method they used 500 c.c. of the blood with no deleterious effects.

DEPRESSED FRACTURE OF THE SKULL INVOLVING SPEECH CENTRE

Dr. John S. Rodman reported the history of a man, thirty-one years of age, who three days prior to admission to the hospital was intentionally struck by a thrown rock in his left temporo-parietal region. He fell to the ground and was momentarily unconscious. Was picked up at once, regained consciousness, but was dazed and had no memory of what had struck him when taken to the accident ward of a local hospital about fifteen minutes later. He was given first aid there, but then allowed to leave, and went to the police station and made a report of his injury. He remembers leaving hospital in a machine and being driven home. Had a good deal of headache and confusion. Vomited after reaching home and at intervals during night. On following day headache continued and vomited once that morning, was restless and complained of continual headache, pain in left arm, shoulder and jaws. Following day about same. He was admitted to hospital on the morning of the third day following accident as his physician felt that he was not improving and that he should be under surgical observation.

The following additional information was obtained from his brother upon admission: There had been no unconsciousness, no incontinence of fæces or urine, no paralysis noted. Very restless, keeps hands to head and complains of light hurting eyes. Asks continuously for water but will not eat solid foods, largely because of pain in jaws. Confused, perception slow and speaks with difficulty. Several attempts before right word is found. Does not sleep but does not notice what goes on around him.

Physical examination made three days after accident. Eyes—pupils equal, react to light, sluggishly to accommodation. Tongue protrudes with difficulty because of stiffness of jaws. No apparent tendency to protrude to one or to the other side. On showing teeth right side of face seems to lag a little and this side of face seems to be smoothed out. Apparently has more power in left than in right arm. No difference in lower extremities. Tendon reflexes diminished. No clonus. Tests for sensation unsatisfactory owing to patient's mental condition, as he is conscious but irritable and mentally dull. Blood-pressure 118-78; P. R. 60; temperature 98. The diagnosis arrived at was extra-dural hemorrhage with fracture of vault. X-ray showed a fracture apparently not depressed, in the left temporo-parietal region.

Operation revealed a circular fragment of skull driven inward over left temporo-parietal region. No extra-dural clot. Dura not opened. The depressed fragment was elevated.

The man, after remaining about same for four days as before operation, began to improve; his mentality cleared; speech returned to normal. He was discharged well, ten days after operation.

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